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VENOUS THROMBOSIS OF THE EXTREMITIES

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ALTHOUGH venous thrombosis and embolism have long been recognized as a frequent complication of surgery, and most frequently a fatal sequela of heart disease, the past decade has seen a revival of interest in the subject, and a re-emphasis on study by exact laboratory methods of the causes, prevention, and treatment.

In the past, the surgeon, of necessity, has directed his efforts toward arresting and preventing hemorrhage by coagulation of the blood, and in so doing he has perhaps failed to place proper emphasis upon the serious consequences which follow this process when it occurs under pathologic conditions.

This paper will deal primarily with this abnormal clotting of venous blood, its causes, sequelae, and treatment. In general, the pathology of venous thrombosis has long been understood, but many of the etiologic factors, as well as methods of treatment, are in a confused and controversial state. Although much progress has been made in the study of this condition, final evaluation of many of the problems may not be possible for a long period of time. The controversy regarding treatment has served a valuable purpose in focusing our attention upon the seriousness of this condition and in stimulating studies regarding treatment which have already done much to lower the mortality and morbidity.

Actually the incidence of thrombosis in the general run of hospital cases is low, being somewhere between .5 and 1.5 per cent.^{1,2,3} On the other hand, this increases tremendously in elderly patients and those undergoing operation for abdominal cancer, prostatec-

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tomy, and pelvic conditions, particularly hysterectomy.^{4,5} The incidence is high following fracture of the hip.⁶ It should be emphasized that venous thrombosis is not exclusively confined to surgical patients since perhaps 50 per cent of the total incidence occurs as a complication of purely medical conditions, of which cardiac diseases predominate.³

Etiology. Many factors have been advanced as an etiologic basis of thrombosis, and in some instances it is impossible to determine the cause. However, three conditions predominate: first, a slowing or retardation of the circulation; second, changes in the vessel wall; and third, those conditions which bring about an increase in the coagulability of the blood. Of these three, a slowing of the circulation is undoubtedly the most common factor. According to Hunter et al,⁷ ". . . the greatest single factor favoring thrombus formation in the lower extremity is sudden confinement to bed of a previously ambulatory older person. . . ." The muscular action ordinarily depended upon to force the return of blood from the extremities is thus radically reduced, and the veins of the legs are compressed by their weight against the surface of the bed. Should an extremity be immobilized in plaster, muscular activity becomes difficult.

The posture of a patient affects the movement of the blood. Fowler's position, for example, results in compression of the vessels at the groin and in the popliteal space. A level recumbent position, or a position in which the head is slightly elevated, allows the blood to pool in the lower extremities. Vasospasm as the result of trauma, as seen in fractures or following any operative procedure, retards the blood flow. A vasospastic condition may also be produced by lowered temperature or by the use of tobacco.⁸ Increased abdominal tension either from gaseous distention or tight abdominal bandages leads to a pooling of the blood in the lower extremities. Local bandaging, as about the knee without inclusion of the area below, acts as a venous tourniquet. The type of early ambulation in which a patient gets up from his bed and sits down in a nearby chair for a period of 15 minutes to an hour each day only induces the stasis it is so important to avoid.

Although the mechanism by which trauma produces intravascular clotting is not known, statistics show a high incidence of thrombosis following injury. Bauer,² in a tabulation of statistics from several Continental hospitals, reports an incidence as high as 14.8 per cent following fracture or other injury to the lower extremities. It is trauma that Homans⁹ refers to as the "X" factor, "not only

among the most active but certainly the most elusive of all thrombophilic influences." One of the most difficult to explain of all the problems of this condition is the development of thrombosis in the lower extremities following trauma elsewhere. Thus, it notoriously follows operation upon the gallbladder and spleen, and it is certainly more prone to occur after extensive procedures within the abdomen. Under such circumstances, injury to the vein itself is not responsible. There is no reason to believe that actual damage to the vein wall occurs in fractures of the hip which so often give rise to thrombosis and subsequent pulmonary embolism.

Local infection in the vein wall may serve as a focal point from which a thrombus develops. The inflammatory process is thought to travel through perivenous lymphatics before it attacks the vein. Allen, Barker, and Hines¹⁰ have stated that degenerative lesions of the endothelium of the veins develop increasingly with advancing age, which they feel might possibly explain the increasing incidence of postoperative thrombophlebitis with age.

Dehydration is known to influence clotting and fortunately, to a large extent, can be controlled. Certainly an increased coagulability of the blood, as that caused by blood dyscrasias, plays a considerable part in the development of thrombosis, but the actual changes which occur, both physical and chemical, are largely unknown. It is quite possible that the determination of these blood changes will eventually lead to the solution of the problem of venous thrombosis.

Symptomatology. There are two distinct forms of thrombosis. They should be differentiated where possible since the treatment of one may vary from that of the other. In one, generally called thrombophlebitis, there is an inflammatory process involving the vein wall, and in the other a non-inflammatory thrombus without vein wall involvement. The latter, described by Homans¹¹ in 1934, was later termed "phlebothrombosis" by Ochsner and DeBakey.¹²

The diagnosis of thrombophlebitis is usually simple and self-evident. There is an acute inflammation of the wall of the vein together with perivascular inflammation. The patient complains of pain and tenderness along the course of the vessels, most noticeable in the iliofemoral region. The extremity is swollen. The superficial veins are dilated. There is an increase in temperature, pulse rate, and white count. Pulsation of the vessels of the foot is poor, probably due to vasospasm. If these symptoms are exaggerated, and if chills are present with wide fluctuations in temperature, supuration is likely.

The patient with thrombophlebitis, unless suppuration is present, is far less likely to suffer detachment of a portion of the clot since it is firmly fixed to the vein wall by the inflammatory process. Subsequent symptoms, however, may lead to an incapacitating chronic thrombophlebitis with edema, ulceration, and recurrent attacks of infection.

Phlebothrombosis is quite another story. Following operation or trauma, either mild or severe, or due to some cause which retards the flow of blood, a bland thrombus may develop in the veins of the lower extremities, usually the calf, without the classic signs of inflammation. The very nature of this type of thrombus without vein inflammation makes it far more susceptible to fragmentation and hence pulmonary embolism. Even under the most careful scrutiny, pain in the chest as evidence of pulmonary infarction may provide the initial warning signal. An elevation of pulse, with or without a slight rise in temperature, may be the earliest sign. Tenderness in the calf or the plantar aspect of the foot, together with pain on dorsiflexion (Homans' sign) can frequently be elicited and is almost pathognomonic of the condition. There may also be some swelling and cyanosis. The lack of symptoms makes this type of thrombosis particularly insidious, and it will be diagnosed only if the patient is carefully watched and frequently examined.

Treatment. As previously indicated, the pathology and diagnosis of venous thrombosis is generally understood and for the most part agreed upon. Concerning treatment there is considerable disagreement mingled with confusion and in some instances personal emotion and prejudice.

Certainly much can be done prophylactically to reduce the mortality and morbidity of this condition. Many of the causes as previously outlined can be eliminated or prevented. It has been pointed out that retardation of the blood flow is the most common factor predisposing to the onset of venous clotting. Consequently, many of the prophylactic measures are directed specifically against this slowing down of the blood flow. The posture of the patient should allow the force of gravity to aid rather than hinder the return of blood from the extremities. So simple a precaution as elevation of the foot of the bed may be a deciding factor in the prevention of thrombosis. Weight reduction in an obese patient should be effected before elective surgery.

Since trauma plays such a large part in the production of venous thrombosis, every effort should be made during surgical procedures to lessen tissue damage. Adequate fluids must be administered to

prevent dehydration. Tight abdominal bandaging does not favor the return of venous blood. However, pressure bandages applied from the toes to the groin force a stronger flow of blood through the deep veins. After operation upon the knee, the bandage should be extended to the toes; otherwise, as has been mentioned, it merely acts as a venous tourniquet. The extremities should be kept warm to encourage vasodilatation.

It should be emphasized to the patient that muscular activity is important and that the legs must be exercised frequently. An exercise routine should be established since the patient, on his own responsibility, is apt to be neglectful. Deep breathing should be a part of the exercise program. While the efficacy of early ambulation in reducing other types of postoperative complications is generally admitted, it has probably failed in respect to venous thrombosis because so frequently patients do no more than get out of bed and sit in a chair. If ambulation is to be effective, it must be ambulation. The patient must be made to walk and exercise the legs. Unless this is done, venous return from the extremities is better effected by keeping the patient in bed with the foot of the bed elevated.

In addition to the preceding methods of prophylaxis, two of more active character have been initiated within the past few years. One is the operative treatment, interruption of the femoral veins, advocated by Arthur Allen and his associates at the Massachusetts General Hospital. In his most recent report, Allen¹³ presents a series of 458 cases in which the superficial femoral veins were interrupted bilaterally in patients 65 years old or over as a means of preventing embolism. In this group, thrombophlebitis occurred in 5 patients and fatal embolism in one. In a control group of the same number, thrombophlebitis occurred in 55 patients and fatal embolism in 26.

Ligation of the femoral veins is not difficult to carry out and can be done under local anesthesia. It must, of course, be bilateral. The superficial femoral vein is the location of choice. It is true that interruption of the femoral veins does not preclude the development of thrombosis in other vessels and herein lies one of the weak points of this method. However, a vast majority of the bland thromboses have their origin in the calf veins which empty eventually into the superficial femoral. Those who do not subscribe to this method of prophylaxis point out further that a great many operations are done needlessly because thrombosis and embolism would be expected to develop in only a small percentage of patients.

On the other hand, if it is reserved for patients as outlined, the number of operations is not tremendous in proportion to all operations, and as a means of preventing fatal embolism certainly should be considered.

The second method of active prophylaxis is the administration of anticoagulants. The advocates of this method feel that the same results, or better, can be obtained as by vein ligation. E. V. Allen¹⁴ of the Mayo Clinic reports the postoperative prophylactic use of dicumarol in 114 patients who had previously had venous thrombosis or pulmonary embolism, and in 284 other operative cases. There were no instances of venous thrombosis or pulmonary embolism. In 716 cases of abdominal hysterectomy, there were 2 instances of minor thrombophlebitis and no instances of fatal embolism, whereas 29 cases of phlebitis and 5 of fatal embolism might have been expected.

A highly reliable laboratory service where prothrombin tests are carried out daily on patients receiving the drug is pointed out by Allen¹⁵ as the "*sine qua non* of treatment with dicumarol."

There are contraindications to the use of this drug: those diseases in which there is a decrease in the coagulability of the blood, as in liver disease, blood dyscrasias, or deficiencies of factors affecting blood coagulability; conditions in which the bleeding potentiality is greatly increased, as in gastric ulcers, large or multiple wounds, or purpura; diseases in which the effect of the drug is magnified or prolonged, as in renal insufficiency; and in operations where complete hemostasis is essential, as in brain or spinal cord surgery.

The effect of dicumarol can be counteracted by vitamin K and fresh citrated blood given intravenously.

Since thrombosis and fatal embolism may occur weeks and even months following operation it is difficult to determine how long a patient should be kept on dicumarol. While the oral administration of the drug is quite simple, daily securing of blood samples by venepuncture and the necessary daily prothrombin test, which is a skilled laboratory procedure, present a very real obstacle in the use of this treatment in patients needing prolonged hospital care or those undergoing long periods of immobilization.

In my opinion, prophylactic ligation has a definite place in the treatment of debilitated, elderly patients who must necessarily be confined to bed, particularly if these patients are confined because of injury to the lower extremities, notably fracture of the hip.

This, of course, is extended to include those in whom anticoagulant therapy is contraindicated.

The most difficult of all the problems concerns the treatment of thrombophlebitis or phlebothrombosis after it has developed. In thrombophlebitis with inflammation and a fixed clot, primary consideration should be given means of treatment such as rest, heat, and elevation, possibly with the use of anticoagulants. Here again, E. V. Allen¹⁴ advocates the use of dicumarol in thrombophlebitis on the basis that it prevents extension of the thrombus, and it is these soft, extending thrombi which do break off. In his report of 280 cases of postoperative thrombophlebitis, subsequent thrombosis or embolism occurred in only 8 cases, with no fatal embolism.

Another anticoagulant, heparin, has been used in the treatment of thrombosis and embolism. Dicumarol action on the blood does not become evident for a period of approximately 24 to 48 hours. Heparin action takes place within a few minutes after injection. For this reason it has been used chiefly, in this country, as an adjunct to dicumarol. Reports from Sweden, however, indicate its successful use, alone, by intermittent intravenous injections. Bauer¹⁶ thus reports its use in 209 cases of acute deep leg thrombosis with 3 fatal cases in patients not operated upon. Loewe and his associates¹⁷ have reported the use of heparin incorporated in the Pitkin menstruum, injected subcutaneously or intramuscularly. The menstruum allows the heparin to be released slowly; the rate of release can be accelerated or retarded by heat or cold, but the effect of the drug cannot be terminated as rapidly as when it is intravenously administered. It must be borne in mind that prolonged use of heparin is an expensive procedure and, like dicumarol, is contraindicated in any condition where hemorrhage is to be especially feared.

Block of the lumbar sympathetic ganglia with procaine hydrochloride as advocated by Ochsner and DeBakey¹² relieves the symptoms arising from vasospasm and prevents many of the complications which sometimes follow thrombophlebitis.

As pointed out previously, patients with thrombophlebitis are less apt to develop pulmonary infarction; at the same time, it does occur. If, under this treatment, pulmonary infarction takes place, ligation is the safest thing to do. Thrombophlebitis frequently begins either in the iliofemoral vessels or so rapidly extends to that point that superficial vein ligation cannot be accomplished above the area of thrombosis. It is possible in these cases to suck out an iliac thrombus through an incision in the superficial femoral vein,

but this in itself is a hazardous procedure and may dislodge a thrombus or force it further up the vessel.

It is the bland thrombus, arising most frequently in the calf veins and presenting few if any early signs or symptoms, which is most apt to produce embolism. Here bilateral superficial femoral vein ligation should be given first consideration. Ligation of this vein, in the presence of thrombosis in the calf veins, does not lead to swelling but may result in immediate improvement in the circulation. If ligation is performed above the profunda femoris, considerable swelling will occur, but it is usually temporary, rarely occurring longer than 6 months, and can usually be controlled by the use of elastic or rubber stockings. If infarction has once taken place, statistics¹⁸ show a 30 per cent possibility of subsequent embolism and an 18 per cent possibility of a subsequent fatal embolism. In the presence of pulmonary infarction and septic emboli, ligation of the vena cava, together with ligation of ovarian veins, if affected, is indicated.

SUMMARY

In spite of the tremendous interest in venous thrombosis, it remains, to a great extent, an unsolved problem. We cannot, at the present time, accept any one method of treatment for every case. Patients whose age or condition marks them as potential victims of this process should receive early prophylactic treatment. In this respect, vein ligation and use of dicumarol certainly have their place. In injury and disease where embolism so frequently follows, such as amputation and hip fracture in the elderly, the author believes prophylactic vein ligation to be the method of choice. Where there is definite evidence of bland thrombosis in the vessels of the calf or the plantar surface of the foot, superficial vein ligation is indicated. Moreover, in the face of septic thrombophlebitis as characterized by chills and extreme fluctuation of temperature with pulmonary infarction, ligation of the vena cava should be resorted to.

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SYMPATHECTOMY IN THE TREATMENT OF THROMBOANGIITIS OBLITERANS

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THE tone of the smooth muscle of the vascular tree may be the primary factor in producing changes in the rate and volume of blood flow to the extremities, manifest by functional circulatory changes, and the course of most underlying organic vascular diseases is greatly influenced by it. The smooth muscle is under the control of the autonomic nervous system: the normal flow of blood is dependent upon an appropriate and balanced outflow of impulses through that system.

Although Galen¹ was aware of the visceral nervous system in the second century, not until 1880 was it approached surgically when Alexander² performed a cervical sympathectomy for epilepsy. In 1913, Leriche³ demonstrated an increase in blood flow to the extremities after periarterial sympathectomy. Hunter⁴ and Royle⁵ in 1924 noted the changes in vasomotor tone following sympathetic section for spastic paralysis, and general interest was stimulated in the treatment of vascular diseases by this means. Since then many reports⁶⁻¹¹ have appeared in the literature concerned with both chemical and surgical interruption of the sympathetic system. In spite of this large number of papers, indications for the procedure have not been clarified and there is disagreement as to the results which may be expected.

The purpose of this paper is to summarize the experience with sympathetic interruption for thromboangiitis obliterans following observation of 113 patients in whom 186 sympathectomies were performed (Table 1). An attempt is made to clarify the indications for surgery and the results which may be anticipated. It is believed that no group of patients warrants a more careful pre-operative evaluation, and that following such studies the surgical outcome in selected cases may be accurately predicted in most instances. Clinical improvement in patients with pain or in whom the vascular incapacity greatly limits activity is readily appreciated, but

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the disappearance of trophic changes, increase in tolerance for exercise or greater tolerance of cold may not be so obvious.

TABLE 1
Analysis of Sympathectomies

	Number of Patients Operated Upon			Number of Operations
	Unilateral	Bilateral	Total	
Lumbar	44	66	110	176
Dorsal	4	3	7	10
Total (lumbar and dorsal)			113*	186

*Quadrilateral sympathectomy, 2 patients; sympathectomy of 3 extremities, 2 patients.

It is beyond the scope of this paper to discuss controversial matters concerning the etiology, physiology or pathology of Buerger's disease. Treatment will be discussed only in so far as relation to sympathetic interruption is concerned.

One hundred and thirteen patients with Buerger's disease were operated upon, and 186 sympathectomies were performed. All of the patients were males. Hebrew patients constituted 35 per cent of the group; the remainder were non-Jewish, white patients except for two negroes. The duration of symptoms varied from one month to thirteen years; the average period was 21.9 months.

TABLE 2
Age of Patients

Years	Percentage
20-25 years	9.4
26-30 years	26.4
31-35 years	35.8
36-40 years	22.7
41-45 years	3.8
46 plus years	1.9

A routine general physical examination was carried out on all patients. An evaluation of their vascular status was carefully made with a detailed physical and instrumental investigation. This examination was carried out in a constantly controlled temperature

room maintained at below saturation humidity in order that observations could be repeated under the same environmental conditions at a later date. All data were recorded on special vascular forms in order that a complete and identical set of repeated observations could be made.

Fifty-three of the records were reviewed in detail with certain significant data obtained. The clinical records of the remaining patients could not be obtained for study following the patients' discharge from the hospital.

TABLE 3
Extremities Involved

Extremities Involved	Percentage
Both Lower Extremities	54.7
One Lower Extremity	39.6
One Lower Extremity, One Upper Extremity	1.9
Both Lower and Upper Extremities	3.8

TABLE 4

Smoking Habit	Percentage
None	5.7
Mild (1 to 10 cigarettes per 24-hour period)	22.7
Moderate (10 to 20 cigarettes per 24-hour period)	30.0
Severe (20 or more cigarettes per 24-hour period)	20.8
Smoking discontinued since onset	20.8

Since it was desired to determine the degree of vasospasm present, a spinal anesthesia was administered and the instrumental determinations repeated. It is believed that in this manner complete, bilateral sympathetic interruption can be produced with no element of doubt left as to the effectiveness of the procedure if vasodilatation is not obtained. The procedure is less painful than a bilateral sympathetic nerve block, is more certain of success, and the loss of sensation and muscle power gives further objective evidence of the time when sympathetic interruption has been attained. By this method the degree of improvement that can be expected immediately after operation is demonstrable. This improvement is ob-

served in the increase, if any, in the oscillometric readings and in the skin surface temperatures of both lower extremities (Table 7).

TABLE 5
Complaints on Initial Examination

Complaint	Present
Pain	66.0%
Coldness	71.7%
Cyanosis	47.2%
Rubor on Dependency	28.3%
Numbness	50.9%
Tingling	41.5%
Burning	15.0%
Anesthesia	7.5%
Stiffness	11.3%
Sweating (Excessive)	47.2%
Claudication	70.0%
Phlebitis, Migratory (history)	32.1%
Rest Pain	24.5%
Edema	20.8%

It reveals the pattern and proportions of the organic and functional spastic elements of the disease in a given patient. All patients showed a rise in temperature of the feet during the test, the magnitude depending upon the degree of vasospasm as well as the extent of development of collateral channels in the extremity. No instances of a fall in skin surface temperatures during this test were encountered.

Sympathectomies were performed in all patients who had ulcerations or gangrene. During the past eighteen months, bilateral lumbar sympathectomies were performed on all patients showing advanced arterial change in one lower extremity, even though only slight change was present in the opposite extremity. As stressed by deTakats,¹¹ all positional changes result in variation in vascular tone of the lower extremities with some degree of vasospasm as one stands. This is essential, in health, to maintain the general

blood pressure. In advanced arterial disease this increased tone is not desirable, since it diminishes blood flow.

TABLE 6
Initial Examinations

	Present
COLOR CHANGES	88.7%
Cyanosis	75.5%
Rubor	39.6%
Pallor	52.8%
TROPHIC CHANGES	
Toes	49.1%
Fingers	3.8%
Nails	26.4%
SCLERODERMA	1.9%
DIMINUTION IN PULSATIONS	88.7%
OSCILLOMETRY (Diminution in)	90.5%
SKIN TEMPERATURES (Thermocouple) (Diminution in)	86.8%
BLANCHING OF FINGERS ON EXPOSURE TO COLD	3.8%

All patients were admonished to abstain completely from the use of tobacco in any form. If this recommendation was not followed after sympathectomy of the more severely affected extremity, no further operations were performed.

Additional therapy consisted of whiskey in small amounts four times daily and local care of the ulcers or gangrenous areas.

OPERATIVE PROCEDURES

The sympathetic nerve supply to the upper extremity is variable but may arise from the first to the tenth dorsal segments of the cord. The postganglionic fibers arising in the ganglia pass from the middle cervical ganglion through the second dorsal ganglion to the brachial plexus. All preganglionic fibers except those from the first dorsal segment of the cord can be interrupted without dividing the postganglionic axons by the operation as developed by Smith-

wick;¹ i.e., division of the rami communicans to the second and third dorsal ganglia and division of the chain below the third ganglion. This type of sympathectomy was performed for all operations upon the upper extremities in this series.

SPINAL ANAESTHESIA VASOMOTOR TEST				
OSCILLOMETRY				
	CONTROL		AFTER SPINAL	
	RIGHT	LEFT	RIGHT	LEFT
Popliteal	5.0 - 100 mm	3.5 - 100 mm	6.0 - 90 mm	4.0 - 100 mm
Tibial	2.0 - 100 mm	1.0 - 100 mm	3.5 - 90 mm	1.5 - 90 mm
Foot	0.5 - 90 mm	0 - 90 mm	2.0 - 70 mm	0 - 60 mm

SKIN TEMPERATURES (°F)				
	RIGHT	LEFT	RIGHT	LEFT
1st Toe	75	79	93	85
2nd "	77	79	92	84
3rd "	77	80	92	85
4th "	77	78	92	84
5th "	77	76	92	83
Plantar	81	80	92	88
Dorsum	83	82	92	88
Ankle	84	85	92	89
Midleg	85	85	92	90
Knee	87	89	91	92
Thigh	89	91	91	92

Room Temp. 76°F.

Table 7. Spinal anesthesia vasomotor test demonstrating proportion and pattern of organic and functional spastic elements of the disease in a patient with thromboangiitis obliterans.

The sympathetic nerve supply to the lower extremity may arise from the tenth dorsal to the third lumbar segments of the cord. The postganglionic axons to the legs arise from the fourth lumbar and upper two or three sacral ganglia. Complete sympathectomy of a preganglionic type may be obtained in the lower extremity by excision of the first, second and third lumbar ganglia. It has been found that sympathectomy is almost complete if the second and third ganglia alone are removed. Since bilateral removal of the first lumbar ganglion may interfere with ejaculation in the male and orgasm in the female, it is usually not resected unless the severity of the condition warrants its removal. The fourth ganglion contains postganglionic fibers to the leg; its removal is not necessary for completeness of the sympathectomy.

It was first observed by Edes¹² that a denervated rabbit's ear would become cool if the animal was excited. In further studies by Heltzers,¹³ Cannon,¹⁴ Smithwick, Freeman, and White,¹⁵ and others, it has been shown that following all sympathetic interruptions a sensitization of the neuro-effector junction of the smooth muscle to internal secretions occurs. A minimal degree of sensitization results if the sympathectomy is performed by division of the preganglionic neuron, and in this manner the maximal reduction of tone of the blood vessel innervated is also produced. Following postganglionic section of the sympathetic nerves, sensitization of the neuro-effector junction to adrenin is three times as great as in preganglionic section.

Lumbar Sympathectomy: Many approaches to the lumbar ganglia have been described.^{8,16,17,18} The operation performed upon these patients was a modification of these procedures.

Continuous spinal anesthesia is routinely used in all cases since the relaxation afforded by it greatly facilitates the procedure. Although the operation may usually be performed in twenty to forty-five minutes, variations in anatomy, the amount of fat about the chain, and the fibrosis and reaction in this region from previous chemical interruption of the sympathetic chain may greatly prolong the procedure. Apprehensive patients tolerate the operation well if sufficient care is given to adequate preoperative sedation. It is the policy to administer a barbiturate the evening before operation and again three hours preoperatively. Hyosine and morphine are given at least forty-five minutes prior to the operation.

No special surgical instruments are required, but the procedure is greatly facilitated if a rigid, shiny retractor to aid in retraction of the abdominal wound and psoas muscle, and to reflect light into the upper portion of the wound is used. A Crile dissector and nerve hook, long scissors and long, light thumb forceps are also desirable.

The operation is carried out on an operating table which can be tilted in all directions. The use of sand bags, mechanical rests or special positions for the patient's body are undesirable. The patient is placed flat on his back with care being taken that he is centered on the table and is not tilted from side to side.

A transverse incision is made at the level of the umbilicus extending from the margin of the rectus sheath laterally for 10 cm. The skin and subcutaneous tissue are mobilized from the fascia of the external oblique only along the line of anticipated division of the fascia. The oblique muscles are divided in the line of their fibers, care being taken not to extend the incision to the costal margin since

this is frequently a source of postoperative pain. The tenth nerve is seen to course over the transversalis muscle and is retracted without injury. Separation of the transversalis muscle exposes the peritoneum. The lateral fat pad is seen when the peritoneum is retracted medially; the fat pad is displaced laterally by blunt finger dissection. The operating table is then tilted to the opposite side.

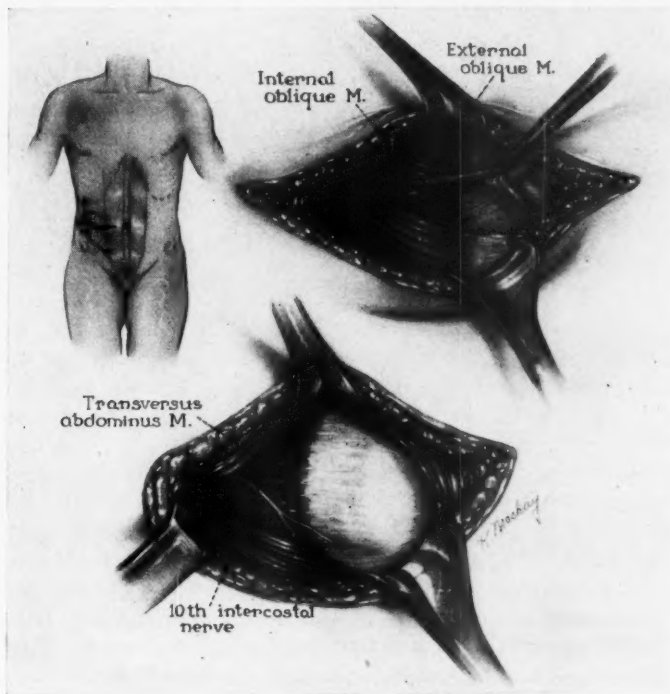


Fig. 1. Lumbar Sympathectomy: A transverse muscle splitting incision is used.

The peritoneum is dissected free from the gutter lateral to the psoas with continued elevation and displacement to the opposite side. The ureter and spermatic vessels are displaced with the peritoneum anteriorly. As the medial border of the psoas muscle is approached the genitofemoral nerve is seen; care should be taken to prevent trauma to this nerve from retractors or in the process of dissection since a transient, painful neuritis of the medial surface of the upper thigh is easily produced. The vena cava or aorta together with the accompanying fat and lymphatics are elevated from the body of the vertebrae exposing the sympathetic chain. The

chain is usually adherent to the prevertebral fascia, but in rare instances it adheres to the vessels.

The sympathetic chain usually runs anterior to the vertebral vessels, but occasionally it runs posterior to them. Great difficulty may be encountered in the removal of a ganglion posterior to a large vessel. There is danger of tearing the veins in this region if a blind dissection of the chain is carried out.

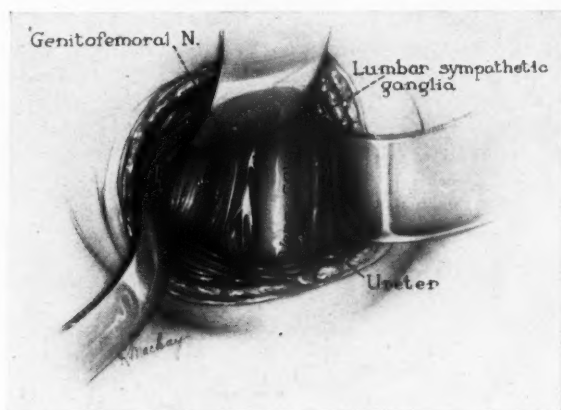


Fig. 2. Exposure of the lumbar sympathetic chain showing relation to the vena cava.

The chains in this group of patients have varied greatly in structure. It has been found impossible to identify the various ganglia by the manner of disposition of the rami communicans. The first and second ganglia were frequently fused or the second ganglion was very small and almost imperceptible on casual examination. In rare instances, no ganglion could be identified even though the chain was completely removed over the second and third lumbar vertebrae; postoperative evaluation of these patients revealed them to be adequately sympathectomized. The procedure has been to identify the third lumbar body by its relation with the crest of the ilium and the third lumbar ganglion, which is usually located near the inferior margin of the anterolateral aspect of the vertebral body. Dissection of the chain with division of its rami was continued superiorly until two ganglia had been removed. This was usually accomplished as the chain was removed from the body of the second vertebra. If it was desired that the first ganglion also be removed, dissection superiorly was continued. Following isolation of the chain, silver clips were applied at the superior and inferior limits

of the points of division. This was done primarily to mark the point of division for further roentgenologic confirmation of the extent of chain removed; it may also inhibit regeneration of the chain.

Bleeding was usually slight but if encountered was controlled with an electrocoagulation current.

A layer closure of the wound was effected with fine interrupted silk or cotton sutures.

Patients were encouraged to become ambulatory on the first post-operative day. Since this policy has been followed, postoperative urinary retention, abdominal distension and discomfort have been infrequent. Early ambulation did not interfere with normal wound healing and produced no unfavorable wound reactions.

RESULTS

Following sympathectomy there was immediate relief of the unbearable pain of aching and burning character in the foot and frequently in the extremity up to the knee or thigh. The pain which persisted was localized to the area of gangrene or ulceration and was described as a slight burning sensation which did not interfere with sleep and which was easily controlled by mild sedatives. Since the extremity no longer had to be hung over the side of the bed to obtain relief from pain by passive congestion which that position afforded, the edema of the foot rapidly subsided. Healing of the wounds was rapid. If the patient continued to smoke an occasional cigarette, the pain did not disappear. If pus, even in small amounts, accumulated under tension under a crusted ulcer, severe pain resulted. This was relieved when the purulent material was drained. In no instance was there a progression of gangrene following operation if the patient had stopped smoking. No previously viable digits became gangrenous.

TABLE 8
Postoperative Results

Total number of patients	113	
Total with Gangrene or Ulceration	32	28.3%
HEALED (Minor amputations)	29	25.6%
Major Amputations	3	2.6%
Extension of Gangrene following Sympathectomy	2	1.8%

Amputation or debridement of gangrenous digits was delayed until 10 days following the sympathetic interruption. It was feared that the transient vasoconstriction in the extremity, which is not infrequently seen from 6 to 8 days after operation, might be a factor which would result in further tissue necrosis in an area already in precarious local vascular balance by the added trauma due to the surgical procedure. In patients with no gangrene, improved functional capacity, as noted by increase in walking distance before the onset of intermittent claudicative cramp, was experienced. All patients appreciated the warmth of the extremities and the increased tolerance for cold.

Major amputations were obviated in all of this group except in three instances. These patients had developed gangrene of a large portion of the foot prior to sympathectomy with the elective site of amputation above the ankle.

SUMMARY AND CONCLUSIONS

1. A summary of the results obtained in the treatment of thromboangiitis obliterans by surgical sympathetic interruption following 186 operations upon 113 patients is presented.
2. The operative technic of lumbar sympathectomy is described in detail.
3. It is believed that sympathectomy is the treatment of choice in thromboangiitis obliterans.

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DIVERTICULA OF THE COLON

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DIVERTICULOSIS of the colon is an ever increasing problem. This fact is established by the many recent reports on this subject. Diverticulitis is frequently encountered and must be considered in all patients with acute abdominal pain, especially in the middle-aged individuals. The differentiation of the obstructive lesions from carcinoma is extremely important in order that early treatment may be instituted. It is for this reason that this statistical review is made to emphasize some of the problems confronted in diagnosis and in treatment, with particular reference to the surgical aspect.

Roentgenographic evidence of diverticulosis varies from 3 to 10 per cent of patients examined.^{1,6,7} The incidence of diverticula as a surgical problem varies considerably with that seen at necropsy. Kocour,⁸ in 1937, found an incidence of 1.81 per cent in 7,000 consecutive necropsies. This figure is probably indicative of the true occurrence of diverticula of the colon. Many series show that the majority of patients with diverticula are above 50 years of age.⁹ Bearse²⁰ reported 7 cases of diverticula in young persons, indicating its rareness in this age group.

The frequency of inflammatory changes in diverticula of the colon is difficult to evaluate. Diverticulitis is variously reported from 10 to 34 per cent^{3,6,10,18} of total cases with diverticula of the colon. Probably 10 per cent is the more accurate. Surgery is required in only 20 to 24 per cent of these cases.^{11,12}

Diagnosis can be made only by direct vision, sigmoidoscopy, or fluoroscopy. Few diverticula are seen by the sigmoidoscope because of their location.⁴ Barium enema may reveal presence in 60 to 70 per cent of patients with diverticular disease,^{5,13} depending upon diligence of search and the ability to fill the diverticulum with barium. Filling may be prevented by inflammation and associated spasm.

The diagnosis of diverticulosis of the colon is rarely made without roentgenographic aid. Diverticulitis, however, presents a fairly typical picture. There is a recurrent history of left lower quadrant

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pain, usually associated with constipation. Frequent intermittent low grade fever and occasional chills occur. Examination may reveal abdominal tenderness and sometimes a mass. Differential diagnosis of the lower colon lesion may be complicated by the presence of obstruction, peritonitis, intraperitoneal abscesses, and fistulae, either external, enterocolic, or vesicocolic. Perirectal abscesses may have their origin from diverticulitis of the sigmoid.

Double contrast media barium enema may be beneficial in diagnosis.^{10,21} Early spasm occurs with wide, transversely arranged folds producing a typical "saw tooth" appearance.²¹ There may be edema of the mucosa, and "spiking" of the processes in the presence of inflammation. The mucosa is practically always intact. In infiltrative lesions the involved portion is usually long with cone-shaped ends. This may be changed following therapy.

Most diverticula are asymptomatic and require no therapy. Medical treatment should be emphasized in an attempt to prevent inflammation in diverticulosis and surgical complications in the less severe diverticulitis. Diverticulosis with symptoms in the absence of acute inflammation may be treated effectively with antispasmodics, sedatives and mineral oil.

Diverticulitis will require more strenuous therapy, which will depend upon the degree of inflammation. A diet free of roughage is desired to prevent enterospasm. Antispasmodics may be of value. Warm olive oil retention enemas may be used daily.

Surgery is not recommended unless there are complications such as perforation, peritonitis, abscess, fistulae, or obstruction. The present trend is to be conservative in the perforated cases. Jones¹⁴ advises only incision and drainage without attempting to close the perforation. Closure should be considered with use of sulfonamides, penicillin, and streptomycin therapy. Operation is advised in infiltrative diverticulitis with obstruction of long duration, or without improvement on adequate medical therapy. In such cases, the most recent trend is adequate preoperative preparation with sulfasuxidine, sulfathalidine, or streptomycin followed by primary resection and anastomosis, with proximal colostomy. Present mortality, by this method, is not as high as with previous staged procedures. Morton¹⁶ advises repair of colonic fistulae after a waiting period following Devine defunctioning colostomy, which allows acute manifestations to subside.

The inability to differentiate obstructive diverticulitis from carcinoma of the colon is a definite indication for operation. Laufman¹²

feels that there is 29 to 50 per cent error in diagnosis between carcinoma and diverticulitis. Both lesions are most frequent in the distal colon and fall into the same age group. Symptoms are similar, but carcinoma is usually the more long-standing and progressive process. The acute lesions may present a firm mass, just as in carcinoma. Blood frequently is present in the stools, but usually less often in diverticulitis than carcinoma.

Barium enema is many times inconclusive in differentiation between diverticulitis and carcinoma of the sigmoid. Schatzki¹⁷ attempts to differentiate the conditions and concludes that accurate diagnosis is "easy in most, difficult in some, and impossible in a few." Probably the most important single roentgenologic finding is the preservation of the mucosal pattern in diverticulitis. It should be emphasized that the only certain means of diagnosis is by microscopic examination of the removed tissue.

The incidence of coexistence of carcinoma and diverticula varies from 1.5 to 8 per cent.^{3,12,18,19} It is probable that there is no casual relationship since the incidence of carcinoma in this condition seems to be no higher than it is for the general population.³

CLINICAL EXPERIENCES WITH DIVERTICULOSIS AND DIVERTICULITIS

A summary is presented of patients seen in Emory University and Grady Memorial Hospitals. This series consists of 119 cases of diverticular disease of the colon. It includes those patients treated from 1939 to date. There were 102 white patients and 17 Negroes.

Diverticulosis was diagnosed in 65 patients and diverticulitis was seen in 54 instances. Symptoms were present in 57 per cent of the 65 cases of diverticulosis. No operative procedure was carried out in any of these cases. Eighty per cent of patients with diverticulosis were in age group of 50 to 79 years. It is apparent that diverticulosis is rare under 40 years of age. Thirty-four per cent of the white patients were in the age group 60 to 69 years. In the negro, the largest number (42 per cent) occurred in the age group 50 to 59 years.

The findings in this review bear out the previous reports that diverticulosis is found most often in the sigmoid and descending colon. It was noted that the sigmoid segment, either alone or in combination with other areas, was involved in 63 per cent, while the descending colon was involved in 80 per cent of cases.

SEGMENTAL LOCATION OF DIVERTICULITIS
OF THE COLON

SIGMOID COLON	33
SIGMOID AND DESCENDING COLON.....	11
DESCENDING COLON	5
ASCENDING COLON	2
TRANSVERSE COLON	1
SIGMOID, DESCENDING AND TRANSVERSE COLON.....	1
ENTIRE COLON	1
TOTAL.....	54

Fig. 1. Chart demonstrating location of diverticulitis of the colon.

The presenting symptoms were variable, but abdominal discomfort was the most constant, being present in 40 per cent of those with symptoms. This was described as being frequently intermittent in type, varying from aching to sharp in character, and usually located in the left lower quadrant. The duration varied from a few days to many years.

Twenty-seven per cent of the diverticulosis patients were constipated. There was a history of the cathartic habit in many, which

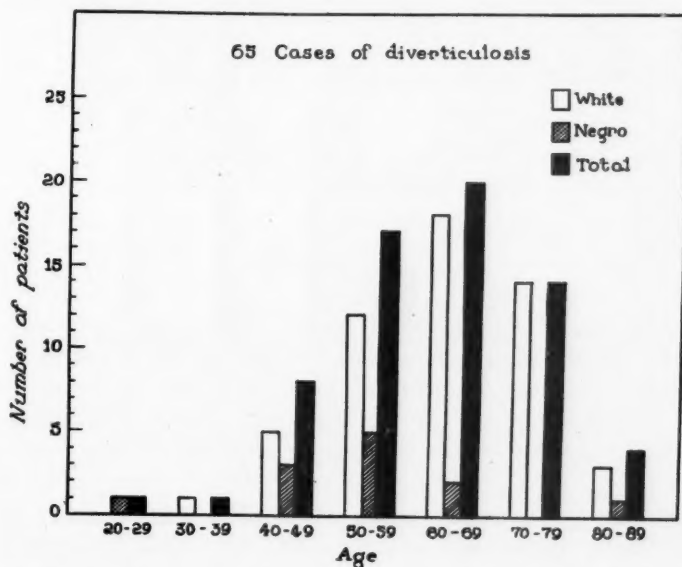


Fig. 2. Chart demonstrating the age incidence of patients with diverticulosis of the colon, with a comparison between the white and the Negro.

in most instances may account for the alternation between constipation and diarrhea frequently seen. Nineteen per cent noted a feeling of fullness and general abdominal discomfort which occurred without the presence of organic obstruction.

The presence of blood in the stools occurred in only 5 of the 57 cases with symptoms. One had moderate amount of gross bleeding. In no instances was there a profound hemorrhage. The corrected percentage is 6.1 per cent of the total cases with bleeding probably associated with diverticulosis.

Fifty-four cases of diverticulitis of the colon were reviewed in this series. There were 48 patients with symptoms (89 per cent). Those few patients without symptoms were seen at various stages of the disease, which may account for the absence of symptoms. The diagnosis in these instances was made by roentgenographic examination.

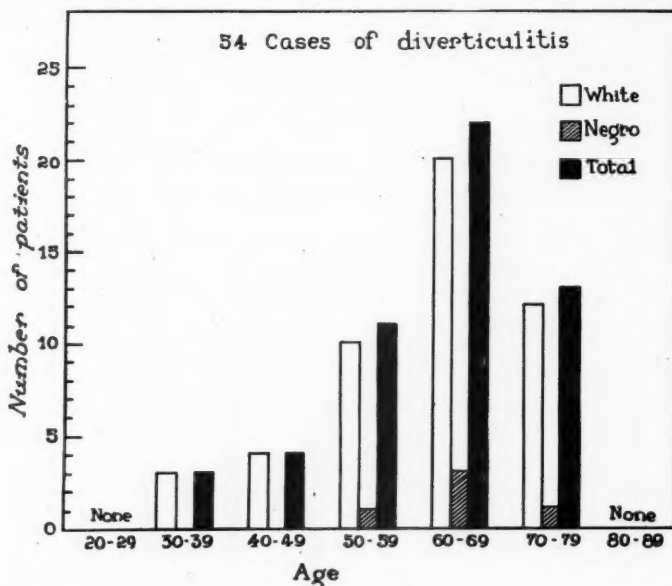


Fig. 3. Chart demonstrating the age incidence of patients with diverticulitis of the colon, with a comparison between the white and the Negro.

Conservative management was universally carried out in this group. No treatment was required in 16 of the 54 (29 per cent). Twenty-nine (54 per cent) required medical therapy. Operative intervention was done in 9 cases (17 per cent).

It is seen from the accompanying chart that there is an age distribution of diverticulitis similar to that of diverticulosis. Eighty-seven per cent of the patients of both racial groups were from the ages of 50 to 79, the largest group being in the seventh decade.

The sigmoid colon, either alone or in combination with other parts, was involved in 83 per cent of the cases, while the descending colon was involved in a similar manner in only 33 per cent. Thus, inflammation affected the more distal segments of the bowel. Perhaps this was due to more impaction of feces and greater mobility of that portion.



Fig. 4. Roentgenogram showing patient with diverticulosis involving sigmoid and descending colon, and large bilateral inguinal hernias, the left hernial sac containing portion of sigmoid colon with the associated diverticulitis.

One of the great difficulties in diagnosis was the differentiation of perforated diverticulitis from other conditions causing local or generalized peritonitis. Due to its relatively increased frequency, appendicitis is more often suspected. Such was the case in 4 instances. A mistaken diagnosis of ruptured peptic ulcer occurred on one occasion.

An obstructive lesion of the sigmoid presents a great difficulty in differentiating between carcinoma and diverticulitis with infiltration. One patient of this series was treated conservatively for 10 months because of the mistaken impression that diverticulitis vis-

ualized by barium enema was the only cause of sigmoid obstruction. Ultimate resection of the lesion proved the coexistence of an infiltrating, grade II adenocarcinoma. This emphasizes the danger of complete reliance upon roentgenographic studies.

Abdominal pain was the most frequent symptom of diverticulitis in this group. It was often sharp in the presence of inflammation or intermittent with mechanical obstruction. The pain was most frequently of short duration, from a few days to a few weeks, with the location usually in the lower abdomen and most often in the left lower quadrant. Sixty-six per cent of these patients complained of pain.

OPERATIVE PROCEDURES

INCISION AND DRAINAGE.....	5
CLOSURE OF PERFORATION.....	1
CLOSURE OF PERFORATION WITH CECOSTOMY AND SUBSEQUENT CLOSURE OF CECOSTOMY.....	1
CLOSURE OF PERFORATION WITH TRANSVERSE COLOSTOMY AND SUBSEQUENT CLOSURE OF COLOSTOMY.....	1
EXPLORATORY LAPAROTOMY WITH NO OTHER PROCEDURES.....	1
EXPLORATORY LAPAROTOMY WITH FREEING OF ADHESIONS.....	1
MIKULICZ RESECTION	1
IMMEDIATE RESECTION WITH ANASTOMOSIS.....	1
IMMEDIATE RESECTION WITH COLOSTOMY OF THE PROXIMAL LOOP....	1

Fig. 5. Chart demonstrating the operative procedure performed.

Low grade fever and chills were frequently present. Leukocyte count varied from 10,000 to 25,000. Blood was seen in the stools of 14 patients. Moderate to massive hemorrhage was encountered in 4 of these cases. Nausea, vomiting, diarrhea, and distension were occasional symptoms. Dysuria was present in 3 patients, but not associated with a fistula.

Eighteen per cent of those with infiltrative peridiverticulitis had progressed to the point of obstruction which needed surgery. Three of the perforated group had general peritonitis, and 5 had local peritonitis.

The operative group is obviously too small and the methods of treatment too varied to draw any conclusions. The introduction of the newer sulfonamide drugs and the benefits derived from the antibiotics will materially influence future operations on these patients. An exploratory operation should be considered in all cases where differentiation from carcinoma cannot be safely made.

It is necessary in most instances to rely not on gross examination but on microscopic examination before a definite diagnosis is made. The present mortality and morbidity in this group should permit a more frequent operative intervention in the doubtful cases.

The following clinical abstracts of operative cases emphasize the various problems and the difficulties encountered in diagnosis and treatment.

1. Localized abscess:

H. D., white male, aged 35, was admitted Oct. 13, 1943, with a history of low abdominal pain, nausea, chills, fever, and dysuria of 10 days' duration. Fluoroscopic studies showed an infiltrative mass in the sigmoid colon with diverticulitis. Exploratory operation revealed an abscess in the left lower quadrant, which was surgically drained. The patient showed improvement under chemotherapy and medical management. He was readmitted 2 weeks later because of partial intestinal obstruction, and remained in the hospital 3 weeks on conservative treatment.

2. Pain in lower abdomen diagnosed as appendicitis:

G. F. H., white male, aged 67, was admitted Feb. 10, 1946, with a pre-operative diagnosis of ruptured appendix. At operation on day of admission, a mass was found in the sigmoid colon which was the location of the perforation causing the peritonitis. A drain was placed in the left side of the pelvis. The patient was placed on penicillin and sodium sulfadiazine. Convalescence was satisfactory, and the wound was healed in one month. This patient died one year later of a myocardial infarction, but had no recurrence of the symptoms of diverticulitis.

3. Generalized peritonitis simulating ruptured peptic ulcer:

H. E., white male, aged 47, was admitted on May 27, 1946, with a history of massive rectal bleeding, cramping abdominal pain, and mild fever of one day's duration. He presented the clinical picture of general peritonitis and was diagnosed as ruptured peptic ulcer. At operation, a perforated diverticulum of the ascending colon was found. It was closed, and a cecostomy was done. The cecostomy tube was removed 2 weeks later. The patient recovered satisfactorily.

4. Obstruction, utilizing conservative surgery, with prolonged morbidity and poor results:

T. J., Negro male, aged 58, was admitted on Nov. 12, 1944, with symptoms of abdominal pain, vomiting, and fever of 6 days' duration. The clinical diagnosis was made of an inflammatory mass of the rectosigmoid with perforation. An abscess surrounding a ruptured diverticulum was found at exploratory operation. The perforated diverticulum was closed, and a transverse colostomy was performed. The colostomy functioned poorly for 5 months and was closed with no further procedures. There was little change from the original roentgenographic findings in subsequent films 2 months after closure of the colostomy.

5. Obstruction, utilizing a safer radical procedure:

C. B., white female, aged 59, was admitted to the hospital on March 15, 1946, with increasing constipation of 5 months' duration. Barium enema revealed an inflammatory lesion of the sigmoid, causing obstruction. The patient was prepared by oral administration of sulfasuxidine for a Mikulicz resection, which was performed one week after admission. Associated small abscesses were found in the region of the lesion in the sigmoid. The colostomy functioned well and was closed two and one-half months later.

6. Obstruction of large intestine and radical surgery without adequate preparation:

S. B., white female, aged 70, was admitted Dec. 24, 1939, with acute obstruction of the large intestine. Twenty-four hours of intestinal suction failed to relieve the distension, and the patient was operated upon under general anesthesia for relief of the obstruction. There was found a perforation of the rectosigmoid above an inflammatory mass, in which carcinoma was suspected. The mass was resected and a colostomy was made of the proximal loop. The patient died 24 hours later of general peritonitis. The pathologic examination did not reveal malignancy.

7. Obstruction associated with carcinoma:

A. H. W., white male, aged 58, was admitted July 4, 1946, with urinary retention and a localized abdominal abscess in the left lower quadrant. No cause was found for the retention. The abscess was drained. X-ray evidence later showed an infiltrative diverticulitis of the sigmoid colon with perforation. Multiple diverticula were seen in the descending colon. The patient improved, only to have a recurrence of the abscess with a second operative drainage in August, 1946. He was re-admitted the following November, and first stage transverse colostomy was performed with hope of later resection. Another abscess developed and was drained in February, 1947. On April 17 the infiltrative mass of the sigmoid was resected, and an accompanying ileocolic fistula was closed. The mass proved to be adenocarcinoma, grade II, arising from the mucosa of the sigmoid colon. A large rectal polyp removed at the same time showed malignant degeneration. The patient recovered from the operation but has developed a fecal fistula in the area of the abscess drainage.

DISCUSSION

Diverticulosis is a disease of the older age groups. It is not an uncommon finding in barium studies of the colon made for other suspected conditions. About half the cases have vague or indefinite symptoms, such as pain in the lower abdomen, which is intermittent in nature and associated with constipation and occasional mild flatulence. Occult blood may be found in the stools, but this is more common when infection supervenes. A prolonged cathartic habit may be important as an etiologic factor.

Simple medical measures such as antispasmodics, mineral oil, and barium salts by mouth have been suggested to prevent inflammatory

complications. This prevention is the most important concern in this stage of the disease.

Diverticulitis develops in about 10 per cent of pre-existing diverticula. It has a similar age and sex incidence to diverticulosis, and its location is predominantly in the sigmoid colon.

Diverticulitis must be differentiated as a factor in all local or general peritonitis or other acute abdominal infections. The age of the patient, the history of the illness, and the location of the pain may be of much help. In either event, early exploration is in order, and the perforation should be closed. Use of omental tabs or simple drainage may be helpful with adequate supportive measures and chemotherapeutic agents.

The present surgical trend is toward less radical methods in the presence of peritonitis or abscess, and toward more radical procedures in the chronic obstructive cases. It is much safer today to do a one stage resection and anastomosis with concomitant proximal colostomy than it was formerly. This advance depends upon more adequate preparation with proper hydration and nutrition, with sufficient blood and use of chemotherapy and the antibiotics.

Fistulae, whether to the bladder externally or to other portions of the intestine, present a difficult problem. Sigmoidovesical fistulae have been reported as more prevalent in the male by 8.5 to 1 per cent,¹¹ presumably because of the protection offered the bladder by the uterus in the female. In some cases this fistula will close after a period of irrigation into a proximal colostomy.⁹ In refractory cases, resection is accomplished many months after preliminary colostomy.

The cases of diverticulitis without complications are treated best by bed rest, local heat, antispasmodics, oral bismuth or barium salts, sedation, analgesics, soft diet, and mineral oil. The primary aim in the treatment is to prevent surgical complications. Surgery, however, should not be delayed when definite indications exist. Indications for surgery are:

- (1) Perforation with general or local peritonitis or abscess formation
- (2) Fistula
- (3) Obstruction
- (4) Inability to differentiate or rule out the coexistence of carcinoma of the same area.

There is still a considerable morbidity and a high operative mortality with diverticulitis. Combined conservative and radical surgery has resulted in about 15 per cent mortality. It is believed that both morbidity and mortality can be lowered significantly with proper medical therapy in the prevention of inflammation in benign diverticular disease, and the prevention of surgical complications in less severe diverticulitis. The importance of carefully chosen surgical procedures is essential with adequate preoperative and postoperative care.

SUMMARY

(1) A series of 119 cases of diverticular disease of the colon is presented, with 65 cases of diverticulosis and 54 of diverticulitis.

(2) Diagnosis and therapy are discussed, with emphasis upon prevention of inflammation in benign diverticula and prevention of surgical complications in less severe diverticulitis.

(3) Case abstracts are presented to show the varied problems encountered and the surgical procedures employed.

(4) Present trends of surgery are evaluated with employment of all supportive measures and less radical procedures in the presence of abscess or peritonitis.

(5) More radical one stage resections of the involved segment are now possible and advocated with the use of nonabsorbable sulfonamides, streptomycin, and proper protein and electrolyte balance.

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CARCINOMA OF THE BREAST

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CARCINOMA of the breast has been reviewed many times in the medical literature, and it is generally agreed that radical mastectomy is the treatment of choice and that end results bear direct relation to the clinical extent of disease at the time the patient is first seen. This paper, therefore, will not go over this ground again, but will be concerned with certain other factors related to cancer of the breast, which have not received as frequent or as exhaustive treatment.

Two hundred and sixty cases of carcinoma of the breast were seen in the Robert Winship Memorial Clinic at Emory University Hospital from 1937 through 1946. One hundred and twelve of these had had previous treatment elsewhere and were referred either because of recurrent disease or for radiation therapy. One hundred and forty-eight patients, however, had all treatment in the Winship Clinic, and it is this group which received detailed study. It is obvious that these are not all 5 year cases, but since the primary purpose of this paper is to point out the relation of certain factors to the response to treatment rather than to give end results, we felt that the larger group of 148 cases formed a better basis for the study than the smaller group of 49 cases, which were treated over 5 years ago.

The impression is rather widespread that the age of the patient is of considerable importance in carcinoma of the breast and that young women who have the disease do very poorly even in spite of early treatment. The results to date in our series do not lend confirmation to this belief. Of 5 patients under 30, 4 are well without evidence of carcinoma at present, and the one who died had widespread disease when first seen and was completely inoperable. Of 19 patients between the ages of 30 and 39, 14 are well at present. In the group of 124, over 40 years of age, 60 are free of disease at present. When these statistics are converted to percentages, it becomes apparent that of 24 women under 40, 75 per cent are well

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at present, whereas of 124 women over 40, only 48.3 per cent are well at present. The question which is immediately asked, of course, is whether this difference can be explained by the clinical extent of the disease when the patients were first seen. This point was carefully investigated, and all cases were classified according to the stage of the disease at the first examination, and the results of the various clinical stages for the various age groups determined. It was found that in Stage I carcinoma where there was no evidence of extension beyond the breast at the time of first treatment, and in Stage II in which there was extension to the axillary lymph nodes but not beyond in so far as could be determined, the results at present in the group under 40 were better than in the older group. It is recognized that the group under 40 is perhaps too small to give completely reliable percentages, but there can be little question but that younger women do just as well as those over 40. They certainly should not be denied early and radical treatment.

TABLE I
RELATION OF AGE TO RESULTS AT PRESENT

	Stage I		Stage II		Stage III	
	No.	% well	No.	% well	No.	% well
Under 30	1	100(1)	3	100(3)	1	0
30-39	10	80(8)	8	75(6)	1	0
40-49	18	72(13)	24	42(10)	1	0
50-59	16	69(11)	17	29(5)	4	0
Over 60	15	80(12)	21	43(9)	7	0

Whether a woman has or has not borne children does not appear to influence the prognosis in carcinoma of the breast. The percentage free of evidence of carcinoma at present was essentially the same for 29 women who had had no pregnancies, for 66 who had had one to three children, for 24 who had had four or five children and for the group of 12 women who had had over five children.

It was thought that the location of the carcinoma in the breast might be of some prognostic significance, and accordingly, this point was studied. Tumors situated in the upper outer quadrant, lower outer quadrant, upper inner and lower inner quadrants and in the central portion of the breast were compared. We found that there

was very little difference in the response to treatment and that the percent free of evidence of carcinoma at present was essentially the same for all groups. We formerly believed that when carcinoma arose in the medial portion of the breast, it was somewhat more likely to metastasize to inaccessible areas and that the outlook was

TABLE II
NUMBER OF PREGNANCIES

	Number of cases	Well at present
None	29	55.2%
1 - 3	66	54.5%
4 - 5	24	58.3%
Over 5	12	50.0%
Unknown	17	
Total	148	

not as good as it would be for lesions located in the lateral portion of the breast. Evidence arising from this study, however, does not support this opinion, and it now appears that the location in the breast is of little consequence in so far as the eventual outcome is concerned.

The relationship of the size of the carcinoma to the response to treatment was investigated. It was found that results were best when the tumors were 1 cm. or less in size, which might of course be expected. With increase in size up to a diameter of 5 cm., the prognosis became steadily poorer. Patients with very bulky lesions, however, did relatively well, and of those individuals in whom carcinoma had reached a diameter of 6 to 10 cm. or more without killing the patient, the percentage which could be rendered clinically free of disease was significantly above that for the tumors of 5 cm. in diameter. Our conclusion is that the type of carcinoma which remains localized until the tumors can grow to large diameters, is somewhat less lethal than is the more active infiltrating type, which has a tendency to metastasize early. The point of some clinical importance is that a carcinoma of the breast is not inoperable just because it is very large, provided no extension can be demonstrated beyond the axilla. The prognosis is fairly good in the bulky tumors of this sort.

We usually think of carcinoma of the breast as being free from pain in so far as the local tumor is concerned. We were somewhat surprised, therefore, to find that 37, or 25 per cent of the 148 patients complained of some pain in the involved breast. In 105, pain was completely absent, and in the remainder, pain was due to obvious extension of the disease to bone or to other distant sites.

TABLE III

LOCATION

	Number	Per cent well at present
Upper outer	71	51 (36)
Lower outer	16	57 (9)
Upper inner	24	50 (12)
Lower inner	4	50 (2)
Central	19	63 (12)

When a patient with carcinoma of the breast is first seen, it is customary for physicians to palpate the axilla as well as the breast, and to examine the patient for evidence of distant metastases. We wondered just how reliable this clinical examination was in so far as detecting the presence or absence of metastases in the axillary lymph nodes was concerned. In 53 cases in which axillary nodes were thought clinically to have been involved and in which the patients subsequently underwent radical mastectomy so that the tissue could be checked microscopically, it was found that the nodes were involved in 46 instances and that no metastases were present in 7, even though palpable nodes were present. On the other hand, in 55 cases in which the axilla was thought to be uninvolved, metastases were found in 11 instances, even though there were no clinically palpable lymph nodes. In the other 44 cases, microscopic examination confirmed the clinical impression. In 10 cases in which the clinician was doubtful about axillary involvement, 5 were found to have axillary disease on examination in the pathology laboratory, and 5 were free of axillary metastases. The significant point here seems to be that one cannot be sure about the axilla, since in 11 instances in our experience it was found to be involved when clinically it was judged to be free of carcinoma.

There have been two schools of thought regarding the use of skin grafts in radical mastectomy. Some surgeons feel that nearly

every case should be grafted, while others believe that it is a procedure which should be reserved only for those cases in which, due to the large size of the tumor or perhaps to its location at the medial border of the breast, it is impossible to remove an adequate margin of skin and at the same time close the wound by primary suture. This group, as a rule, closes most radical mastectomies without grafting. We have followed this latter procedure and were interested to know whether or not we were having an undue incidence of skin recurrences, which might be attributed to it. Of the 106 patients in our series who had radical mastectomies, 3, or 2.8 per cent, have developed local recurrences. This incidence is sufficiently low to convince us that skin grafts need not be employed routinely. We do wish to emphasize, however, the necessity for developing very thin skin flaps and for carrying the dissection medially to the sternum, laterally to the latissimus dorsi, and inferiorly to include a portion of the rectus fascia, and to dissect the axilla from the apex downward with meticulous care. Hemostasis and a wide dissection are emphasized rather than operating time, and 3 to 4 hours are usually required to complete the procedure.

The incidence of complications following radical mastectomy has been relatively low. We have had no deaths at the time of operation or during the subsequent hospital stay. The incidence of postoperative edema of the arm was 9 per cent in those cases which had postoperative radiation and 4.7 per cent in those which did not receive x-ray therapy. It is probable that the difference is not entirely due to the x-ray therapy, however, in as much as the cases receiving postoperative radiation had axillary involvement, whereas those which did not receive it for the most part were free of axillary disease.

It has been our custom to give postoperative x-ray therapy to the axilla when the axillary lymph nodes are involved by metastatic carcinoma, and to withhold it when they are not involved. There have been some exceptions to this rule, however, and in reviewing our cases, we found that the group which had surgery alone included several cases which had axillary involvement and that in 10 instances, postoperative x-ray therapy was given when the axilla was not involved. The percentage free of disease at present is a little better in both Stage I and Stage II groups for those cases which had radical mastectomy alone. Certainly it is not possible to state that the postoperative x-ray has improved the result. However, our series is not a satisfactory one for an accurate comparison of the two methods of treatment since there is no doubt but that the most advanced cases with the most active types of tumors were

given postoperative x-ray therapy, and that therefore this group would be less favorable. At the present time despite lack of statistical evidence to prove the point, we believe that there may be some advantage in giving postoperative x-ray therapy to the axilla when the axillary lymph nodes have been involved. We do not routinely give it to the chest wall. In our opinion, there is no advantage in using it at all when the carcinoma is confined to the breast

TABLE IV
FIVE YEAR RESULTS

	Number	No evidence of carcinoma
Stage I	20	16 or 80%
Stage II	22	9 or 40.9%
Stage III	7	0
	49	25 or 51%

except in extremely active, high grade tumors. Radiation therapy alone has proved to be of definite palliative value, but is not usually sufficient to bring about prolonged control of breast carcinoma. Modified surgical procedures, on the other hand, seem to have a place in extremely poor risk patients. In 7 cases, a modified type of radical mastectomy was done, when it was obvious that the patient would not tolerate a radical mastectomy. This modified procedure usually included a simple mastectomy plus a partial axillary dissection. This is not a procedure of choice, but sometimes has to be used, and of the 7 patients so treated, 4 are free of evidence of recurrent or metastatic carcinoma at present. Simple mastectomy has an extremely restricted use in the management of carcinoma of the breast. It is occasionally employed as a palliative measure to remove a foul smelling, ulcerated lesion which is causing the patient considerable distress, and we have used it on rare occasions in very elderly women with Stage I tumors. Both of these latter procedures should be considered only in those very few cases in which radical mastectomy cannot be done.

Forty-nine of our cases were treated 5 or more years ago, and in this group we are able to present 5 year results. Twenty of these cases were in Stage I and of these, 16, or 80 per cent, have lived 5 years or more without evidence of recurrence of carcinoma. Of the 22 cases in Stage II, 9, or 40.9 per cent, are free of carcinoma for 5 years or more. All but one of the patients in Stage III have

died and one patient, although still living, has definite metastatic disease. Twenty-five, or 51 per cent, of the 49 cases treated over 5 years ago are free of evidence of carcinoma at present.

SUMMARY

Experience with carcinoma of the breast during the past 10 years has been reviewed. Evidence has been presented to indicate that the results in young women with carcinoma of the breast are equal to those in older women. The number of pregnancies does not appear to influence the response to treatment. The location of the carcinoma in the breast does not seem to be of prognostic significance. The most careful clinical examination can sometimes be incorrect in so far as axillary involvement is concerned. If thin skin flaps are developed and the dissection carried widely, skin grafting need not be routinely employed, although there will always be certain cases in which it is necessary. Present methods of treatment lead to control of carcinoma of the breast for a period of 5 years or more, in 80 per cent of the patients treated when the disease is confined to the breast, and in approximately half as many cases when extension to the axilla has occurred.

MODERN METHODS OF THE DIAGNOSIS AND TREATMENT OF MEDIASTINAL MASSES

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THE mediastinum has long remained one of the final barriers to the diagnostic and therapeutic attack in the field of medicine. Great steps of advance have been accomplished in recent years due to both the improvement in such diagnostic measures as roentgenology and the technical advances in thoracic surgery. The purpose of this communication is an attempt to summarize and evaluate the present methods of diagnosis available relative to mediastinal lesions, and to remark briefly upon the therapy involved. Several new methods of investigation have recently become available, and it is felt advisable to evaluate the usefulness of these methods as well as the indications for the use of the same.

By definition, the mediastinum is that portion of the thorax which is bounded laterally by the right and left mediastinal pleurae; the thoracic cage behind; the sternum in front; the diaphragm caudally; while the upper limits of the mediastinum consist of an arbitrary line going from the suprasternal notch to the first thoracic vertebra. There is a definite value in the topographic division of this territory into four main sections. Thus the anterior mediastinum constitutes that area between the sternum and the heart, and contains the thymus gland. The heart and pericardium are contained in the middle mediastinal section, while the posterior mediastinum is that space posterior to the pericardium which lies between the arch of the aorta and the diaphragm. The final division is called the superior mediastinum and consists of that portion extending from the arch of the aorta to the suprasternal notch, and from the sternum to the spinal column.

The value of this differentiation lies in the fact that these four segments, each individually, include certain organs which are liable to a predominance of certain types of lesions and disease entities. Thus the anterior mediastinum brings to mind pathologic states associated with the thymus gland or ectopic thyroid tissue. The middle mediastinum incorporates the diseases of the heart and pericardium. It is well to mention here, due to the frequent misunderstanding concerning the involved anatomy, that the ascending aorta is an intrapericardial structure in all patients, at least as far

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as the innominate artery, and frequently as far as the right common carotid. The superior vena cava, on the other hand, is extrapericardial almost throughout its length. The remaining two segments of the mediastinum, namely, the posterior and superior divisions, contain the greatest variety of organs and therefore involve a greater degree of diagnostic differentiation. The posterior mediastinum is comprised of the descending aorta, the lower trachea, the main bronchi, the lower portion of the esophagus, the superior and inferior vena cava, the thoracic duct, and the sympathetic, vagus and phrenic nerves. The superior mediastinum contains the arch of the aorta, the upper portions of the thoracic duct and esophagus, possible thyroid tissue, as well as the upper portion of the sympathetic, vagus and phrenic nerves.

Throughout all portions of the mediastinum one finds considerable areolar connective tissue and lymphatic glands. The most constant sites of lymph glands, however, are in the anterior portion of the posterior mediastinal segment about the trachea, main bronchi and the major pulmonary vessels. An adequate understanding of this divisional anatomy plus the realization that the mediastinum is a midline structure, and therefore liable to contain cysts of developmental origin, constitutes the fundamental basis for the diagnostic approach to shadows found in the mediastinum.

The mediastinum has the dubious privilege of being an area in which disease processes produce relatively few or late symptoms. The symptoms remain of vague definition until the process has achieved sufficient size to exert pressure upon surrounding structures. It is a highly protected area, making the discovery of physical findings either difficult or impossible, until size again produces physical findings by pressure, especially upon the vascular trunks.

The symptomatology of these lesions has been much neglected, for in the main in recent years lesions in this area presented only a diagnostic rather than a combined diagnostic and therapeutic challenge. Today almost every lesion in the mediastinum is amenable to curative, or at least palliative, therapeutic measures. This means that accuracy in diagnosis is demanded if we are to fulfill our responsibilities relative to these lesions. It has been the experience of all who are interested in thoracic work, to have patients with mediastinal disease presented to us with the statement that "the lesion is visible on the x-ray only, and there are no symptoms or physical findings." The symptomatology of these lesions is not as yet fully comprehended. We know that the interested observer, upon questioning these patients after x-ray discovery of a lesion,

will find frequent, very vague and bizarre symptoms which may be attributed to these lesions. In dealing with any disease of the thoracic cavity one should remember that except for the parietal pleura, the entire tissue complex is under autonomic nervous control only; furthermore it should be mentioned that the parietal pleura of the mediastinum is less sensitive than that over the lateral thoracic wall. Therefore, one must postulate that the sensations derived from lesions of the mediastinum must be those which arise from stimulation of the efferent or afferent branch of the autonomic system.

Thus, lesions in the thoracic sympathetic chain may produce referred pain through the reflex arch to the intercostal nerves, or a highly situated lesion may produce a Horner's syndrome, while lesions involving the vagus nerve complexes may give bizarre sensations due to reflex upset in the respiratory mechanism, cardiovascular or gastrointestinal system. We are all familiar with the frequency with which patients having lower esophageal disease give history of prolonged treatment for suspected gallbladder disease or peptic ulcer syndrome. As we investigate the history in retrospect, relative to posterior mediastinal tumors, we are more and more frequently encountering a history of preoperative indigestion relieved by the removal of the posterior mediastinal tumor. Unfortunately, bizarre symptomatology arising from stimulation of autonomic nerve trunks is often too vague or confusing to the individual patient for him to present himself because of these symptoms.

The physical examination relies, in the main, upon inspection for evidence of the production of collateral venous circulation, upon auscultation of the chest with particular interest toward the presence of evidence of compression upon the tracheobronchial tree, and careful blood pressure readings to compare the blood pressure in the individual extremities, both upper and lower. While we are concerning ourselves with the phenomenon of pressure upon vital organs, we are reminded to inquire relative to symptoms of possible extrinsic pressure upon the esophagus, or upon the lungs or heart, such that localized wheezes appear in certain positions, or sensations of cardiac instability or arrhythmia may appear in certain positions. A complete physical examination relative to the thyroid gland, lymphatic tissues, liver and spleen, and the presence of collateral circulation, is a standard portion of the diagnostic approach to mediastinal tumors.

In summary, therefore, the history and physical examination are exposed to severe limitations. This is due, in part, to the underlying

nature of the disease, the anatomy of the area involved, and to our present day status of comprehension of symptoms and physical findings of mediastinal origin. The practical aspects of diagnosis, therefore, make us rely upon specialized technics of diagnostic study in order to define the nature of lesions in the mediastinum.

The intelligent use and interpretation of the x-ray constitutes our strongest potential diagnostic weapon. We must realize the limitations involved in this technic. X-ray views are two-dimensional only, and lesions in the mediastinum may be hidden by surrounding structures until films involving a variety of views are obtained. Certainly the standard postero-anterior and lateral films should constitute a routine in the study of mediastinal lesions. In the author's experience stereoscopic x-rays and the use of the roentgenkymogram have been sufficiently disappointing in lesions of the mediastinum that they need to be utilized only in extremely rare instances.

In all lesions involving the mediastinum the patient must of necessity undergo a proper fluoroscopic investigation. In lesions where there is a suspicion of vascular origin the angiocardioqram, cardiac catheterization, venous pressure and blood pressure studies may be of considerable value. A proper understanding of the segments of the mediastinum leads to a much more intelligent interpretation of the lateral x-ray picture of mediastinal tumors.

With the fluoroscope one is able to view the mediastinum from multiple directions and properly to evaluate the types of special film studies which are necessary. Furthermore, fluoroscopy allows us to inspect the function of the diaphragm which reflects the relationship of the phrenic nerves to underlying mediastinal pathology. The barium swallow allows us to evaluate the esophagus as well as the effect upon the esophagus of surrounding structures. With the advent of improved x-ray technic, allowing the opacification of the vascular tree and the increased direct surgical approach upon lesions of vascular origin in the thorax, we have obtained a greater appreciation of some of the limitations of fluoroscopic investigation. The presence of pulsation in a structure may indicate that a lesion is of vascular origin, or that it is a mass closely approximated to a vessel, so that such pulsation is transmitted rather than intrinsic. This latter phenomenon is most commonly encountered in soft thin-walled cysts. The absence of pulsation in no way rules out a vascular origin to the mediastinal shadow. In recent experiences with 28 intrathoracic aneurysms, 70 per cent of the lesions did not pulsate under fluoroscopic vision. The rationale of this

finding is much better appreciated after one has attacked such lesions surgically and noted that such aneurysms do not pulsate until a markedly thickened overlying layer of pleura has been removed from the aneurysmal sac. In case of doubt relative to the vascular origin of a mediastinal shadow there is no substitute for the proper use of the angiocardigram.

In certain instances there is considerable value in the use of air as a contrast and separation medium, either in the pleural or peritoneal cavities. We are all acquainted with the value, in certain cases, of the injection of air as a contrast medium and as a method of separating the pulmonary tissues from the mediastinum. In centrally placed shadows the institution of a diagnostic pneumothorax frequently tells us whether a lesion is primarily of pulmonary or mediastinal origin. These same principles are involved in lesions situated at the cardiophrenic angles bilaterally, allowing us to localize the origin of such shadows in relation to the diaphragm. Therefore, in certain instances the institution of a pneumoperitoneum may tell us whether such lesions are primarily intrathoracic, of diaphragmatic or intraperitoneal origin. In some of the abnormalities of the diaphragm, especially diaphragmatic herniae containing omentum without actual bowel, barium studies of the intestinal tract may show sufficient distortion of intestinal segments to suggest displacement of the omental apron.

There are two other methods of investigation with the roentgen ray which are relatively new and are still somewhat in the process of evaluation, in regard to their limitations. These two methods are described as laminography and angiocardigraphy. The laminogram has been of some use to us in the study of masses throughout the thoracic cavity. This technic has also been described as planography and relies upon the ability of making exposures at certain depths within the thorax, or planes at the varying levels, starting from the posterior surface of the patient's back on through to the anterior surface of the thorax. This method has obtained considerable value in evaluating potential cavities in the apex, and especially the presence of cavities following collapsing procedures such as thoracoplasty. The majority of these exposures are made in the postero-anterior position and are not so satisfactory in the lateral view because of the amount of tissue which needs to be penetrated. In relation to mediastinal tumors the use of laminography has been relatively limited in our experience. The point of greatest value in such investigation has been in lesions which lie in the paravertebral sulcus, especially lesions which are considerably flattened by the overlying pleura. On one occasion a lesion which had all the ap-

pearance, on the postero-anterior films, of being a small area of atelectasis in a child and in whom bronchography failed to reveal an obstructed bronchus, laminography revealed the exact flattened detail of a ganglioneuroma. A similar instance of considerable value was found in a patient of 23 years of age in whom a small flattened, elongated mass was found in the paravertebral sulcus at the level of the ninth and tenth dorsal vertebrae on the left. On all other studies this mass was quite vague and in large part the shadow was confused by the overlying diaphragm and heart shadows. However, with the use of the laminogram this mass was proved to be present and distinct, and on exploration was found to be a bronchogenic cyst. We have also used this method in the investigation of patients with myasthenia gravis in whom the lateral film projection suggested the possibility of an anterior mediastinal mass.

This method has been of considerable use in telling us of the presence or absence of a lesion in the upper portion of the thymus, but does not define lesions confined to either lateral lobe. In recent months we have also used this method for the definition of suspected mediastinal glands in relationship to neoplasm in the pulmonary tree. The results to date have been quite satisfactory in proving the presence of glands. This allows the surgeon to appreciate the extent of surgery which will be required in a pulmonary resection, but the frequency with which the enlarged glands are purely inflammatory instead of metastatic neoplasm makes us feel that a positive finding of such glands can in no way rule out an attempt to remove the underlying neoplasm. The use of this procedure in thoracic surgery is still quite new and needs considerable evaluation before we can determine its exact place in the therapeutic and diagnostic armamentarium.

One of the most exciting advances in radiology consists of the angiocardioqram. This method consists of the rapid injection of 50 c.c. of 70 per cent Diodrast into an antecubital vein, and the taking of multiple rapid x-ray exposures of the thorax to visualize the passage of blood throughout the lesser circulation and its movement through the aortic arch in the major circulation. In good hands this procedure carries a very low element of risk. It has been our policy to consider patients to be disqualified for this procedure if there is any clinical evidence of major spasm of the bronchial tree, serious renal disease, or evidence of marked sensitivity to iodine. This procedure has been carried out at this University on over 200 occasions without any major catastrophe to date. The patients usually complain of a very severe "flushing sensation," and there may be occasional mild syncope, nausea or vomiting. It is

frequently necessary to carry out this procedure in different positions in order to evaluate fully the underlying vascular abnormality. The greatest value of this procedure has been in the determining of the potential vascular origin of mediastinal masses.

As noted above, the presence or absence of pulsations in mediastinal masses in no way guarantees the vascular or avascular character of the mass. In the first film obtained with this procedure, there is always a good demonstration of the superior vena cava, and in certain conditions the displacement of the vena cava laterally has allowed us to be sure that an upper thoracic mass was mediastinal rather than pulmonary in origin. In patients having abnormalities of a congenital type of the cardiovascular system, this procedure is becoming of increasing value. On at least three occasions during the past two years, mediastinal masses which had been treated elsewhere with deep radiation therapy were proved by this method to be vascular in origin, and subsequently the underlying lesions were surgically corrected. To date we have been impressed with the positive value of this method of investigation and we feel that its limitations are very few. It has been interesting to note, on certain occasions, that patients with carcinoma of the lung who undergo this procedure tend to show a marked absence of filling of the vascular tree in the area of neoplasm.

The author has purposely restricted the mention of diagnostic x-ray therapy into the last category in the description of the use of x-ray in the evaluation of mediastinal masses. It is felt strongly that this procedure has been greatly misused in the past. Only too frequently has it been our experience to find an operable lesion which has undergone roentgen therapy to no real purpose other than to increase the difficulties of the operative procedure. Furthermore the fundamental principle of an exact diagnosis prior to therapeutic measures is not being adhered to in the practice of diagnostic roentgen therapy. Certainly, no lesion of the mediastinum which is smooth in contour should be subjected to this approach. Certain lesions of the mediastinum may be sensitive to x-ray therapy and yet be better treated by resection. The classic examples of this, of course, are the malignant tumors of the thymus, of a substernal thyroid, and malignant teratomata. It is felt in this clinic, that a lesion which receives x-ray therapy must be situated in the glandular portion of the posterior mediastinal segment, namely, its anterior portion. The lesion, moreover, must be irregular in contour, and have undergone complete preliminary investigation.

It has not been felt necessary to include within the scope of this

paper any description of the proper types of laboratory investigations relative to the hematologic system which must be carried out in the presence of mediastinal masses. Furthermore, in anterior mediastinal lesions which are suspected of being teratomatous, it is hardly necessary to mention the value of special urinary studies for androgenic substances.

Even with a complete investigation such as that described in the foregoing paragraph, there are still certain lesions which may be accurately defined only by a direct visualization of the tumor mass. Such instances are fortunately rare. There are two methods available of direct observation of the mediastinum, namely, the use of the thoracoscope and exploratory thoracotomy. Neither of these procedures should entail a mortality. The thoracoscope as a diagnostic agent of mediastinal masses has been found to be required only in rare instances. The first requirement, of course, is to show a satisfactory collapse of the lung away from the mediastinum after the institution of artificial pneumothorax, following which some value may be expected from insertion of a thoracoscope.

In our experience this has been most valuable in the presence of mediastinal lipomata and cysts situated at the cardiophrenic angle. When such lesions are discovered they usually require removal, but in certain patients the physical condition may be such that surgery should only be contemplated for a definite malignancy. In such an instance recently, in a man of 52 years of age who had suffered a coronary occlusion three months previously and had been subject to repeated right lower lobe pneumonia, a mass was discovered in the right cardiophrenic angle. A small pneumo-peritoneum was instituted revealing the lesion to be above the right diaphragm. A small right pneumothorax was then started and revealed the lesion to be extrapulmonary. Therefore a thoracoscope was inserted and a cystic mass found to arise in the right cardiophrenic sulcus. The mass was needled and fluid aspirated, after which air was injected. The fluid revealed a few of the elements which one would expect to line a pericardial cyst and the x-rays taken with the air in place showed no communication with pericardium and that the cyst had a smooth inner lining. It was therefore felt safe to observe this lesion and to make a diagnosis of pericardial cyst.

In patients who are in good general physical condition and in whom a definite diagnosis is not obtainable, we feel that it is recommended to carry out an exploratory thoracotomy. Prior to recent methods for the therapy of intrathoracic aneurysms this approach might be subject to criticism, but now we feel that lesions vascular

or avascular are amenable to therapy and therefore exploratory thoracotomy in a patient in good general physical condition is justified and recommended.

The emphasis in this paper has been laid upon the diagnostic methods available in relation to masses discovered in the mediastinum. The therapy of these lesions can be summarized in relatively brief form. All mediastinal lesions other than the lymphomata should be treated by surgical excision, unless vascular, in which case some form of aneurysmorrhaphy is recommended. This statement is based upon the fact that at least 80 per cent of all masses occurring in the mediastinum are at least potentially malignant. All malignant lesions other than lymphomata, of course, require excision. The benign lesions have at least a 40 per cent chance of becoming malignant either due to transformation of the underlying cell structure from benign into a malignant category, or by sufficient enlargement of the benign tumor to press upon vital structures and therefore prove hazardous to the patient's existence.

Scattered reports have constantly occurred in the literature, in which the excision of localized lymphomata is recommended. The author has had no personal experience in attempting to remove malignant lymphoma of the mediastinum. However, it is felt that an open mind should be kept in regard to this lesion.

SUMMARY AND CONCLUSION

The author has attempted to present the present status of the diagnostic and therapeutic approach to masses in the mediastinum. Emphasis has been laid upon the division of the mediastinum into four segments and the value of this classification in the reading of lateral x-ray films. The insidious course of mediastinal tumors has been emphasized both in regard to the paucity, or vagueness, of the symptoms involved and in the relative absence of physical findings until the lesion has become of marked size. Some mention has been made of the bizarre symptomatology which is seen in association with mediastinal tumors, and it is hoped that a better evaluation of such symptomatology will be available as further study progresses.

The fundamental method of investigation of mediastinal tumors involves the intelligent use of x-ray films, fluoroscopy and certain specialized recent advances in roentgenography. Proper laboratory studies and physical examinations are of course expected in the investigation of these lesions. In the experience of the author the stereoscopic film and the roentgenkymogram have been disappointing adjuncts in the study of mediastinal tumors. Laminography is

proving of increasing value in the study of these lesions, especially lesions situated in the paravertebral sulcus and in the anterior mediastinum. Sufficient value has been noted in angiocardiology to make one feel that this must be considered whenever a mediastinal mass is presented.

The use of air contrast media in the pleural and peritoneal cavities has been discussed, as well as the value of thoroscopic investigation and exploratory thoracotomy. It is well to mention that in certain instances cardiac catheterization studies may prove of value in mediastinal lesions of vascular origin. It is felt that the value of this method of investigation in mediastinal masses is mainly that of being complementary to angiocardiology.

This article has not been presented to discuss the therapy of mediastinal masses in any detail, other than to mention that any such lesions may be a potential candidate for surgery. The use of diagnostic deep x-ray therapy in masses of the mediastinum is of limited value, should only be used after satisfactory and complete investigation and not be subject to indiscriminate abuse.

SPINAL CORD TUMORS

And the Similarity of Their Symptoms to Those of Other
More Common Diseases

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A REVIEW of the medical histories of 50 patients with histologically proved intradural tumors of the spinal cord made it obvious that the diagnosis of these lesions was not always an easy one. In the majority of these cases, exclusive of the diagnoses of neuritis, multiple sclerosis and sciatica, it was not until paralyses, anesthetics or sphincter disturbances appeared that these patients were suspected of having central nervous system disease. Prior to the subjective or objective appearance of these symptoms, these patients had been classified and treated for the more common diseases that occur outside the spinal canal. This therapeutic grouping varied from spontaneous subarachnoid hemorrhages of the cerebrum to the paresthesias of the lower extremities which developed in the course of a supposedly primary pernicious anemia. A complete study of these 50 cases will form the basis for another report; sufficient for this communication will be 9 of the patients, who at some period or other in the course of their illness were treated for, or considered to be general surgical problems. It is hoped that by presenting the experiences of these 9 patients such an approach to this subject will be effective in stimulating the earlier recognition of tumors within the spinal canal, and that it will also offer an explanation for abdominal and thoracic symptoms that are not too typical of the more common surgical diseases of these cavities. For the accomplishment of this purpose, case abstracts will be given, and symptoms and diagnoses will be discussed only from the standpoint of neurologic evaluation. Before details of the more outstanding case experiences are presented, a few facts concerning spinal cord tumors in general and some statistical information on the 50 cases in this series may be of interest.

In the review of the 50 records, it was learned that a lapse of 3 weeks to 20 years had occurred before a pathologic diagnosis was made. The average interval was 48.6 months. In view of the fact that the incidence of benign lesions of the spinal cord is in reverse

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ratio to tumors of the cerebrum, the majority of tumors within the spinal dura are of a benign character. In the 50 cases of this study, 37 of the tumors were benign (Chart 1), and total extirpation was

50 Intradural Spinal Cord Tumors

Location		and	Tumor Types		
CERVICAL	7		Congenital		2
CERVICO-DORSAL	2		1. Arachnoid cyst	1	
			2. Dermoid	1	
DORSAL	20		Glioma		12
			1. Astrocytoma	5	
			2. Ependymoma	5	
			3. Unclassified	2	
DORSO-LUMBAR	16		Hemangioma		2
LUMBAR	2		Hodgkin's (primary)		1
LUMBO-SACRAL	3		Lipoma		1
			Meningioma		10
			Neurofibroma		22

Chart 1. 74 per cent histologically benign.

performed. The time lapse from onset of symptoms until a pathologic diagnosis was made would suggest that spinal cord tumors are not frequently suspected. Irreparable cord damage can result from compression over too prolonged a period even though the growths may be totally removed. The spinal cord without too extensive intrinsic fiber destruction has the ability of remarkable physiologic recovery so that no patient, however complete the neurologic symptom damage may appear, should be denied the benefit of surgery. As for surgical results, there is no body area where the neurosurgeon functions more effectively and consistently than within the spinal canal. In cases below the highest cervical levels of the spinal cord, the surgical mortality is negligible, and the morbidities are in ratio to the histologic disease.

CASE 1 (28-197): Appendectomy, Cholecystectomy. Nephropexy—Laminectomy, Neurofibroma 11th Dorsal Spinal Root.

Patient was a male, aged 42 years, who for 4 years had suffered attacks of abdominal pain. These were intermittent cramping, knife-like in character, and located in the right abdominal region. The pain was occasionally associated with nausea but never with vomiting. There was no other history of disturbed gastrointestinal function. After his various general surgical procedures netted no relief, he had repeated gastrointestinal x-ray studies, and a final diagnosis of psychoneurosis was made. After 4 years, sensory and motor handicaps developed in his lower extremities. Neurologically his sensory level extended up to the 12th dorsal segmental level. A complete block within the spinal canal was demonstrated on spinal manometric investigation. Following the removal of a neurofibroma attached to the 11th dorsal spinal root, com-

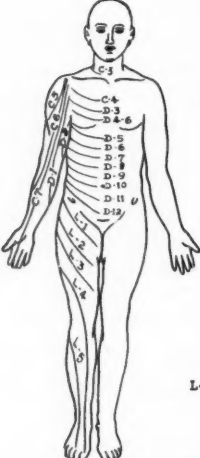
plete and permanent relief of the abdominal pain and a rapid subsidence of his neurologic symptoms ensued.

This case illustrates the most extreme in general surgical efforts in any of the 18 cases of the total of 50 spinal cord tumors. The pain which this man suffered was quite characteristic of the pain of spinal cord tumors, and it was the hope of relief from this that undoubtedly prompted him to accept any advised surgical procedure. In all the cases abstracted in this report, pain was the initial symptom and in many instances persisted for a long interval before the appearance of other subjective neurologic manifestations. Generally in intradural tumors of the spinal cord, the early appearance of pain and latent development of vesicle sphincter dysfunction is indicative of a subdural tumor originating outside the spinal cord proper. Early bladder or rectal sphincter disturbances in the absence of pain symptoms in such tumors is grossly characteristic of intramedullary growths.

The type of pain which is produced by a spinal cord tumor is rather constant. Varying somewhat to a minor degree in each individual, it is constant in its persistence and location, and usually progressive in its intensity in each patient. It is usually described as a "cramp-like," sharp, shooting in character, or frequently a "knife-like" pain beginning in a particular small focal area and coursing in a radial manner, following the anatomic distribution of the nerve root or the spinal cord segment involved. It is quite characteristic of this nerve root pain that it is exaggerated on prone rest and relieved on activity. These patients famously get out of bed at night and walk about for relief. Coughing, sneezing, straining at stool, vomiting, heavy lifting or any physical act that elevates the intraspinal pressure is likely to intensify or initiate the appearance of pain of spinal root origin. Simple bending maneuvers which entail no physical strain may likely be performed early in the course of a spinal cord tumor without the production of any symptom and may be carried out without any manifestations of a physical handicap. As has already been alluded to, activities of a moderate degree are conducive to the patient's comfort.

Spinal cord tumors may occur at any level in the cord from the first cervical level to the 2nd sacral even though the dorsolumbar zone is the most common site of origin (Chart 1). With such a wide distribution, it is understandable why the pain from a lesion, depending on the site of origin, might simulate occipital neuritis (C1 & 2), a scalenus anticus syndrome (C5, 6, 7), pleurisy or thoracic disease (D2, 3, 4, 5, 6, 7), gallbladder disease (D8-9), gastric

pathology (D9), appendicitis (D10), renal colic (D11, 12, L1, 2) (Chart 2). Of course, in these previously mentioned conditions there are other characteristic symptoms and physical findings, or there is recourse to diagnostic procedures to confirm or exclude such pathologies. In early spinal cord tumors, pain is likely to be

	Spinal Level	Spinal Reflex Levels	Common Surgical Diagnosis
	C 1-8	Biceps C 5-6	{ Cervical Rib Scalene Syndrome "Wry Neck" Brachial Neuritis Cervical Disk
		Triceps C 6-7	
		Supinator C 7-8	
	D 1-12	Upper Abdominal D 8-9	{ Ulna Neuritis Scalene Syndrome Flourish Paroxysmal Tachycardia Gastric Ulcer Gallbladder Disease Appendicitis Intestinal Obstruction Renal Disease
		Mid Abdominal D 10	
		Lower Abdominal D 11-12	
	L-1 S-2	Cremasteric L 1-2	{ Renal Colic Appendicitis Sacro-iliac Disease Lumbar Arthritis Lumbo-sacral Injury Hemorrhoids Ruptured Disk Sciatic Rheumatism Sciatic Neuritis
		Patella L 2-4	
		Gluteal L 4-5	
		Achilles L-5 S-2	

Segmental root innervations and reflex levels (after Bing) and the more common clinical impressions for which the majority of the 50 cases in this series were initially treated.

Chart 2.

the only symptom, and there are no physical findings. Nor will any of the usual general medical or surgical laboratory procedures prove to be of other than negative value. A long history of pain, persistent in location and character, even over a period of years, in the absence of other neurologic symptoms does not exclude a spinal cord tumor possibility.

CASE 2 (38-382): Nephrectomy. Sciatic Nerve Injection. Exposure and Direct Alcohol Injection of Sciatic Nerve. Hemilaminectomy, Removal Ligamentum Flavum. Laminectomy, Meningioma 2nd Lumbar Level.

Patient was a woman, aged 37, who for 5 years had suffered intensely with pain which originated in her right posterior flank and radiated into her groin. After the removal of her right kidney, the original site of her pain was unchanged but the radiation became sciatic in distribution. Her pain was throbbing in character, was exaggerated on too prolonged rest, and was intensified on straining at stool. Shortly before she was studied neurologically her pain became continuous and neither medication nor activity gave her any relief. Following direct alcohol injection into the surgically exposed sciatic nerve, there was a complete "drop-foot" and a sensory loss in the sciatic nerve dis-

tribution of that extremity. There was an accompanying atrophy of the dorsiflexor muscles of the calf. Aside from these produced neurologic handicaps, neurologic examination was otherwise normal. Her pain was not relieved. A hypertrophied ligamentum flavum was removed from between the 5th lumbar and 1st sacral laminae. At this time a complete spinal canal block was demonstrated. Several months later following the removal of a meningioma from the 2nd lumbar level, her "renal and sciatic pains" were alleviated. The direct sciatic nerve handicap from the alcohol damage to this structure ultimately resulted in a trophic ulcer.

In spite of the fact that the interval between the onset of pain in spinal cord tumors and the subjective appearance of other neurologic symptoms may even be one of several years, a careful neurologic examination may bring out objective findings to support a clinical suspicion of central nervous system disease. In earlier sensory disturbances, it is necessary that the examiner institute some educational efforts so as to acquaint the patient with minor impairments in sensation, for even in patients with advanced handicaps in sensations repeated tests are frequently required to develop an accurate localization of the abnormal with the normal skin levels. These sensory tests should include light touch, painful stimulation, appreciation of temperature changes and vibratory sensibilities, two-point painful discrimination, and position and joint sensibilities. In addition to these more common tests, there are electrical methods of determining skin resistances which may prove valuable in the early objective search for spinal cord pathology. Sweating tests may also be quite helpful in supporting early clinical evidence of intradural growths.

It is rather unlikely that the examiner will be able to demonstrate any gross impairment of motor function in a patient before this handicap has become a subjective symptom. Diminished or increased muscle tones, fibrillary muscular twitchings or measurable atrophic muscle group asymmetries may be objectively discovered before such symptoms are noted by a patient. If there is direct motor tract or segmental motor root involvement, reflex changes may be elicited long before motor weaknesses ensue. In such cases, it is important to keep in mind certain spinal reflex levels within the spinal cord (Chart 2). The abdominal reflexes for the upper responses are localized at the 8th and 9th dorsal levels; the mid and lower, at the 10th, 11th and 12th segments. The superficial reflex responses are most commonly the earliest destroyed in pyramidal tract or motor spinal root compressions. A hyperactive knee jerk (L2-4) or a sustained ankle clonus may be the only objective evidence of a spinal cord tumor. The presence of pathologic reflexes (Babinski, Oppenheim, etc.), or the absence of deep reflex

responses can be explained only on a neurologic basis. A disturbance of sphincter function, either vesicle or rectal, irrespective of the weight of clinical evidence, should prompt one to suspect central nervous system disease and evaluate such a dysfunction in the light of this possible explanation for the other attending symptoms.

CASE 3 (32-247): Appendectomy. Tetany. Syphilis. Laminectomy—Ependymoma, 8th Dorsal Level.

A female, aged 20 years, suffered abdominal cramping nocturnally, with increasing severity. There was no vomiting, but gaseous distention of her abdomen was frequent. After 2 years her appendix was removed, and she was told it was not diseased. Her abdominal pain continued, and the etiology of it was not determined. Following the development of cramping muscular pains in her lower extremities which were also nocturnal, she received a course of antiluetic therapy. When sensory and motor handicaps in her legs developed, degenerative syphilitic spinal cord disease was suspected, but a block in her spinal canal on spinal puncture for confirmation of the luetic diagnosis led to her laminectomy. An ependymoma from the dorsal 7th level to the 10th was disclosed and grossly removed. This was followed by relief of her abdominal pain, but the cramping motor handicaps in her extremities continued.

CASE 4 (40-113): Renal Disease. Cystoscopy. Congenital Ureter. Exploratory Laparotomy. Laminectomy, Neurofibroma 8th Dorsal Spinal Root.

Patient was a female, aged 44 years, who for 2 years had suffered pain in her left upper abdominal region. Shortly after onset, the seizures became very severe. They were sharp in character, fairly localized to this upper quadrant. They were attended by no gastrointestinal symptoms, but straining on urination or bowel evacuation intensified her pain. Pyelographic studies disclosed a congenital hydro-ureter on the left. Cystoscopic treatments were thought by her initially to give relief; after these became ineffective an x-ray study of her gastrointestinal tract was reported as depicting a deformity in the upper part of the descending colon. Exploratory laparotomy proved this lesion to be a minor peritoneal adhesive band. Her abdominal pain continued; became more common and more severe, and with the appearance of numbness in her lower extremities, she was suspected of having some spinal cord disease. Neurologic examination netted a sensory impairment well up on the abdominal wall, and there was an increase in the deep reflexes with a diminution in the superficial reflex responses. Following the removal of a neurofibroma from the 8th dorsal spinal root, her abdominal pain immediately disappeared and her meager neurologic handicaps rapidly cleared.

A study of the spinal fluid in suspected cases of tumors is the most valuable procedure of all the investigations. Historical information may be misleading, neurologic examinations may be normal, but even in early tumors within the dural canal, the spinal fluid examination is not likely to be normal when a complete microscopic and chemical study is performed. The most common and earliest change in the fluid that one can expect is an increase in the globulin, protein elements. A partial or total obstruction in the spinal canal

as depicted on the Queckenstedt procedure is the confirmation of the clinical diagnosis. In many instances a feebly delineated neurologic problem may, within 24 hours after a spinal puncture, become a sharp, clear-cut clinical picture. The explanation for this artificially produced increase in symptoms is theoretically on a mechanical basis. The pressure below the obstruction is reduced, the potential arachnoidal water bed at the tumor level is altered, and the spinal cord is crowded further against the bony canal by the tumor compression. Vascularization of the cord and tumor is immediately changed, and intensification of symptoms follows. A knowledge of this happening is valuable in understanding that surgery of a spinal cord tumor can become an emergency.

CASE 5 (40-373): Peptic Ulcer. Medical Treatment. Surgery Advised. Laminectomy, Neurofibroma 9th Dorsal Spinal Root.

A male, aged 20 years, suffered epigastric pain for 11 months, the character of which except for its intensity simulated ulcer. The pain was epigastric and was relieved on eating. There was no nausea or vomiting. He not infrequently got out of bed, took some food and derived relief. After medical efforts proved ineffective, surgery was recommended. He sought further medical advice at which time there had appeared some minor numbness and weakness of his legs. The patient further noted a change in the location of his epigastric pain, in that it seemed to originate in the posterior axillary line on the right and radiate into the right upper quadrant of the abdomen to the epigastric region. Neurologic examination revealed a mild spastic motor handicap in the two legs with a sensory diminution over these members which extended up on the trunk to the 9th dorsal dermatome. Laminectomy revealed a neurofibroma attached to the posterior root of this 9th dorsal intraspinal nerve.

The longest story of suffering of any in the entire 50 selected records was a history extending over a period of 16 years (Case 3). It is a well-known histologic fact that ependymal gliomas may be extremely slow growing. There are recorded cerebral lesions, verified by biopsy, that have been symptom-free for years, following simple decompression efforts. Thus, a long-standing story of focalized pain does not ever totally exclude a tumor of the spinal cord, even though after a lapse of years there are no supporting objective or subjective cord symptoms. The spinal cord may be the site of origin of any of the gliomas that are found within the brain. However, the larger number of spinal cord tumors are neurofibromata and meningiomas. Hodgkin's disease, primary melanomas, dermoids and almost every neoplasm of endodermal and mesodermal origin have been described. The malignancies, whether of primary neurogenic origin or from other tissues within the spinal dura, are in the minority. The greatest number of malignancies that affect

the spinal cord are secondary invasions and usually involve the vertebral structures. An example of a direct secondary, intradural metastatic cord invasion has not occurred in our entire series of extra- and intradural tumors.

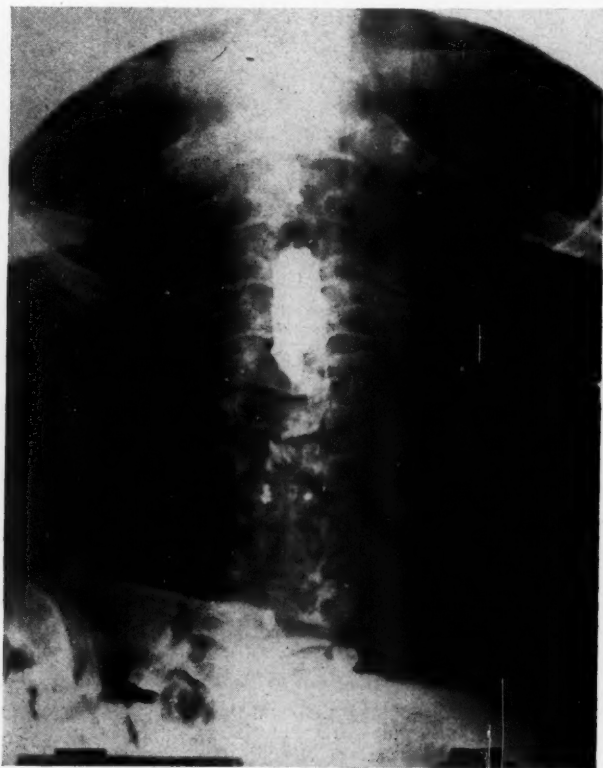


Fig. 1. Illustrates all the radiologic changes which may be encountered in spinal cord tumors—erosion of the pedicle, widening of the laminal arch, obstruction of the opaque oil.

CASE 6 (46-64): Pelvic Disease—Pelvic Exploration. Renal Disease. Left Hydronephrosis. Laminectomy, Neurofibroma First Lumbar Spinal Root.

A female, aged 28 years, had suffered sharp, cutting, paroxysmal pain in her left lower abdominal quadrant, radiating into the groin. This pain when present was intensified upon straining at stool and on coughing or retching. Twelve months after the onset of symptoms a pelvic laparotomy was performed; the details of this procedure were unknown to the patient. Her pain was not relieved and increased in its severity. It became so severe and in-

capacitating that pyelographic studies had to be performed under spinal anesthesia. In spite of ureteral draining of a diseased kidney, her pain was not influenced. After the relief which she had during spinal anesthesia had disappeared, massive doses of opiates were necessary for the relief of her pain. Objective neurologic examination was extremely vague in value. A complete



Fig. 2. The neurofibroma is diagrammed so as to emphasize the deformity details destroyed on reproducing this x-ray film.

block of the spinal canal was found, although the flow of fluid was reported as being normal at the time of the anesthetic administration. At laminectomy a neurofibroma was removed from the first lumbar root, and she was immediately relieved of her "pelvic, renal pain."

The radiologic studies indicated in suspected spinal cord tumors are those of x-ray of the vertebrae and fluoroscopic study of the spinal canal, using some contrast media (figs. 1, 2). One cannot expect any bone changes of the vertebrae early in the development of intradural tumors. These films are more valuable for the exclu-

sion of primary or secondary vertebral disease. Late in the expansion of intradural neoplasms, laminal erosions, widening of these structures in their horizontal measurements (fig. 3), erosion or enlargement of the nerve root foraminal exits may be depicted on stereoscopic lateral or oblique x-ray films.

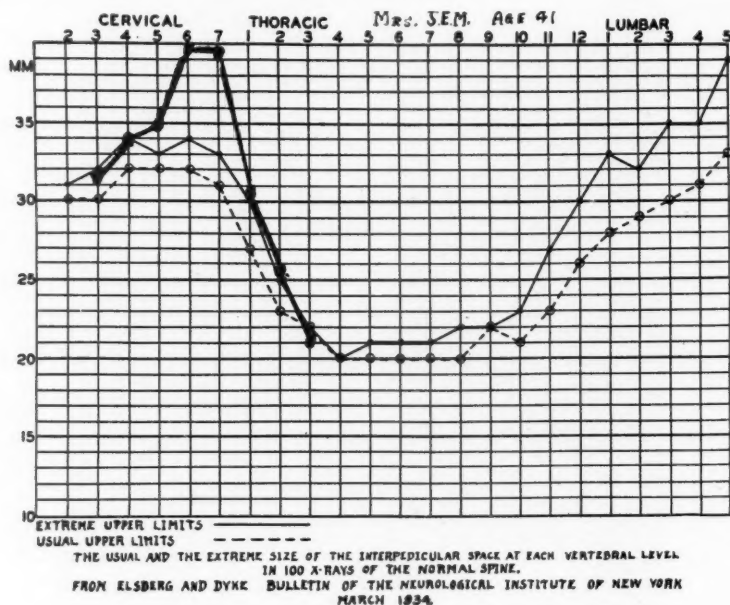


Fig. 3. Interpedicular widening as charted from the x-ray film of Figs. 1, 2.

The choice of a contrast medium for the spinal canal is a personal one. Opaque oils and air are the materials in vogue at the present time. Air is rapidly absorbed, does not irritate the meninges, but does not permit the sharp delineations as do the radiopaque oils. Pantopaque is irritating to the meninges, but being less viscid than lipiodol may be recovered through the same spinal puncture needle by which it was injected. Lipiodol is not so easily recovered on spinal puncture, is less irritating to the meninges, but its radiopaque physical properties are retained for years.

A study of the spinal canal with some contrast material in suspected tumor cases may be more valuable at times than a study of the spinal fluid. In any instance where there is a partial or complete block within the canal and a laminectomy is anticipated, contrast studies should always be carried out. One not only obtains valuable

information concerning the character of the growth, but localization is absolutely established.

CASE 7 (30-130): Pulmonary Tuberculosis, Hemathorax, Pott's Disease. Dumbbell Tumor Spinal Canal and Thorax. Laminectomy, Neurofibroma 10th Dorsal Spinal Room—Thoracic Extension.

A girl, aged 3 years, suffered intercostal pleuritic pain for 12 months. She developed a mild scoliosis. She was put into a plaster cast, put to bed and treated for pulmonary tuberculosis. Attempts at thoracentesis were futile. She developed an acute urinary retention and at this time was found to have a minor sensori-motor handicap in her lower extremities. These neurologic handicaps were thought to confirm the tubercular diagnosis, and a spine fusion for Pott's disease was considered. X-ray films of the chest at the time of this consideration depicted a large thoracic tumor mass paravertebrally located in the right lower lobe. Spinal block was found on spinal puncture. Laminectomy revealed a dumbbell neurofibroma with the intraspinal lesion extending from the 8th to the 11th dorsal levels. The intrathoracic portion of the tumor was removed at a subsequent operation.

CASE 8 (43-63): Pleurisy. Intrathoracic Disease. Gallbladder Disease. Laminectomy, Astrocytoma 8th Dorsal Level.

A woman, aged 36 years, suffered thoracic pain for 6 months. At first considered a case of simple pleurisy, her pain became more severe, was exaggerated on coughing and lying down. Thoracic disease was suspected clinically but was not confirmed on radiologic studies. From a focal sharp 7th dorsal intercostal scapular pain, it radiated to the upper right abdominal quadrant. There were some minor gastrointestinal symptoms, and gallbladder disease was suspected. Laparotomy was considered. A vesicle sphincter loss prompted a neurologic examination. The objective findings on this examination were not sufficient to venture an accurate opinion. A complete block within the spinal canal on spinal puncture was found. At laminectomy a glioma of the cord at the 8th dorsal level was uncovered. Partial removal and a liberal decompression were effective in relieving the patient's pain.

The thorax is not as frequently maligned surgically as being the site of disease from a spinal canal lesion as is the abdominal cavity. On the other hand, Pancost tumors, thoracic aneurysmal vertebral erosion and cord compression and bronchogenic carcinoma with intercostal nerve pressure have been initially suspected of being primarily spinal cord tumors. Thus in the dorsal territory the neurologist functions more commonly in a reverse prognostic capacity than in a positive capacity. The larger number of spinal cord tumors are located between the 8th dorsal and the 4th lumbar levels. There is no cord level from the foramen magnum to the tip of the dural sac at the 2nd sacral level at which all types of intradural growths may not originate. It is easily understandable that the pain of intercostal nerve root pressure or pleurisy, being radial in

location, intensified on coughing and straining, might well be confused with the pain resulting from an intradural growth. Perhaps the physical findings and radiologic depictions of chest pathology permit more accurate diagnosis in thoracic problems than in abdominal conditions. This is offered as another interpretation for the greater number of spinal cord tumors being suspected of abdominal rather than thoracic disease.

CASE 9 (42-191): Arachnism. Acute Surgical Abdomen. Laminectomy, Meningioma 12th Dorsal Level.

A woman, aged 36 years, without any previous symptoms, developed sudden and violent mid-abdominal pain. At the onset there was no suggestive radiation. The pain was described as cramping in character, knife-like, and was not alleviated with mild doses of opiates. There was nausea but no vomiting. The intensity of the pain, and likely the physical findings, suggested spider bite; exploratory laparotomy was discussed. She developed some cramping in her lower extremities and insect poisoning was again thought to be the explanation of the acute clinical picture. A loss of sphincter control centered attention on the central nervous system. Aside from an increase in deep reflexes, there was no other suspicion of spinal cord disease. On spinal puncture, a complete block within the canal was discovered. A meningioma removed 3 weeks from onset of symptoms from the 11th and 12th dorsal region gave complete relief.

It is not generally known that the removal of a spinal cord tumor may be a surgical emergency. The violent, uncontrollable pain from which these patients can suffer may demand immediate relief. There are other instances in which the symptoms of cord compression progress in a matter of a few days to the alarming picture of a total transverse myelitis. When one recognizes that benign and not necessarily malignant tumors can produce such a picture, and that any type of cord compression can result in irreparable damage, emergency undertakings are well grounded. The acuteness and completeness with which neurologic symptoms can develop following spinal fluid studies has already been referred to. This acute change in symptomatology has prompted an immediate laminectomy in more than one experience.

In summary, over a period of years a tabulation of the various diagnoses and conditions for which patients with proved spinal cord tumors have been treated has been made. It was alarming in a review of these tabulations to note that 36 per cent of 50 proved intradural spinal cord tumors had been subjected to one or more general surgical procedures which did not prove helpful in allaying these patients' original complaints. Since the majority of spinal cord tumors are benign and since intrinsic spinal cord damage is the basis for a total rehabilitation or the morbidities in these pa-

tients, the need for early recognition of spinal cord tumors is obvious. Pain is frequently the dominating symptom in intradural tumors of the spinal cord. It is consistent in its location and character, and may exist for months or years before further neurologic symptoms are subjectively recognized. There are clinical and laboratory procedures that may permit a diagnosis before these latent subjective symptoms appear. The pain which these people suffer is segmental in distribution and as such, any body organ or tissue structure located within the region of the segmental nerve supply is likely to be suspected as the locus of disease. Eighteen such cases were considered as general surgical problems from a series of 50 cases reviewed. Nine of these have been briefly abstracted and the clinical problems of intradural tumors of the spinal cord are discussed.

POSTERIOR TIBIAL NERVE INJURIES

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DURING the war years large numbers of peripheral nerve injuries were studied in Army general hospitals designated as Neurosurgical Centers. In civilian practice, the opportunity to observe such numbers of nerve injuries occurs rarely. At Ashford General Hospital 109 patients with injury to the posterior tibial nerve were observed among 2,269 patients who had sustained peripheral nerve injuries. The incidence of tibial nerve injury in this series is 4.8 per cent, slightly higher than that reported from World War I, where the incidence ranged from 1.1 per cent to 2.8 per cent.¹ Injuries to the tibial component of the sciatic nerve are not included.

In most textbooks of surgery there is scant mention of injuries to the tibial nerve, and the reader may be left with a lack of appreciation for the disability that may follow such injuries. The distribution and functions of the tibial nerve are comparable to that of the median and ulnar nerves in the upper extremity. The disability in the hand that follows injury to the median and ulnar nerves is well known; an anatomically similar disability in the foot follows injury to the tibial nerve. The causalgic pain of variable degree which frequently follows injury to the median nerve may likewise follow partial lesion of the tibial nerve.

With severance of the tibial nerve above the innervation of the calf muscles, there is inability to plantar flex the foot or toes. This results in a lack of "spring" to the step with a consequent limp. With injury to the nerve in the middle or lower third of the leg, there is usually no marked limp since the paralysis is of the intrinsic muscles of the foot only. However, this loss of the finer movements of the toes interferes with balance and handicaps the adaptability of the foot to uneven surfaces, or in running. Balance and stability are further impaired by loss of sensation over the sole of the foot and toes.

The atrophy that follows denervation of the intrinsic muscles results in relaxation of the arches of the foot, a claw deformity of the toes, and in loss of some of the soft-tissue protection over the weight-bearing bony prominences. With persistent anesthesia, trophic ulcers are prone to occur over the bony prominences when

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near-normal activity is attempted. These ulcerations, once established, are difficult to heal and frequently recur with minimum use of the extremity.

The disability that may follow either complete or incomplete lesions of the tibial nerve is of sufficient magnitude to warrant considerable caution in advising or performing elective severing, crushing, or alcohol injection of the nerve for relief of pain in certain vascular diseases of the extremities.

ANALYSIS OF CASES

The location of injury in the 109 cases was as follows: lower thigh, 9; popliteal space, 19; upper third of leg, 17; middle third of leg, 37; lower third of leg, 15; and ankle region, 12. The lesion was considered complete in 33 cases and partial in 76 cases. With one exception the injury had been produced by a bullet or shell fragment. The exception was a partial lesion of the nerve that followed Steinmann pin fixation of a simple fracture of the lower third of the tibia. The nerve injury was accompanied by fracture in 37 cases.

The incidence of vascular injuries and complications is perhaps slightly greater in this series than is usual because the cases were observed in a Vascular Center, and many were sent to this hospital primarily for the vascular disability. Nevertheless, a reasonably high incidence of vascular injuries might be expected because of the close anatomic relationship of the nerve with the popliteal and posterior tibial vessels. Ligation of the accompanying artery was recorded in 17 cases; 9 of these were in the middle third of the leg, 4 above and 4 below this level. One patient developed thrombosis of the popliteal artery several days after sustaining an extensive injury in the popliteal region. Arterial aneurysm with false sac developed in 4 of the patients in this series; 3 of the aneurysms were at the ankle level, and 1 was in the middle third of the leg. One was treated at an overseas hospital by ligation of the vessel above and below the aneurysm, 1 was treated by an endoaneurysmorrhaphy (Matas), and 1 was excised at this hospital; the fourth underwent a spontaneous cure by thrombosis and resolution. Arteriovenous aneurysm accompanied the nerve injury in 9 patients. Quadruple ligation and excision of the fistula was performed in each of these patients; the procedure was accompanied by neurolysis in 5 patients and by neurorrhaphy in 2 patients.

Causalgic pain was a frequent complaint of the patient with partial lesion of the tibial nerve. There were 38 patients in this series

who complained of burning pain in the distal portion of the foot at the time of their arrival at this hospital. The nerve lesion was essentially complete in only 3 of these patients; neurorrhaphy was performed in 2, and the treatment of the third had not been completed at the time of closure of the hospital. The severity of the causalgic pain is recorded as mild in 15, one requiring sympathectomy; moderate in 17, 7 requiring sympathectomy; and severe in 6, 6 requiring sympathectomy.

Persistent anesthesia was considered a greater potential disability than was muscular paralysis. Twelve patients presented ulcerations over the heel or sole of the foot at some time during their hospitalization. Three of these patients with trophic ulcers had only partial lesions of the tibial nerve. These ulcerations occurred in spite of the rather protected and limited activity of the patients. It is believed that most patients who have complete lesion of the tibial nerve will develop ulcers with activity that approaches normal. For this reason, the completeness of anesthesia over the weight-bearing areas of the foot determined largely whether exploration or other extensive procedure would be carried out in an attempt to improve the function of the nerve.

In 61 of the 109 cases it was believed that no operative procedure at the site of nerve injury was necessary, although 8 of these required sympathectomy for relief of causalgic pain. The remaining 48 patients had an exploration of the nerve at the site of injury. In only 17 patients was a neurolysis performed. It was believed that a neurolysis alone had very little to offer the patients with partial lesions of the nerve. For this reason, if the patient had some motor function and sufficient sensation over the sole of the foot to prevent ulceration, an exploration and neurolysis was not considered desirable. In the few patients who were subjected to neurolysis, no appreciable change was noted in either the rapidity or the degree of return of function. Likewise, the procedure was not found to alter the causalgic pain in a single instance.

Of the 33 patients with complete lesions of the tibial nerve, 28 had definitive suture of the nerve—5 of the repairs performed in overseas hospitals and 23 performed in this hospital. Three patients were considered to have irreparable injuries after extensive exposure of the nerve; grafting procedures were not done. The treatment of 2 patients had not been completed at the time the hospital closed.

It has not been possible to follow the results of the treatment, and definite statements cannot be made concerning the ultimate

value of the procedures used. The few patients who were observed for several months after a satisfactory neurorrhaphy usually had a rapid advance of Tinel's sign and beginning return of sensation over the sole of the foot. In none, however, could return of function of the intrinsic muscles be demonstrated.

OPERATIVE TECHNIC

As this group of nerve injuries was being studied, the technic of bridging the larger defects in the nerve underwent some changes. In general the trend was toward more extensive mobilization of the nerve. It was believed that a definitive repair of the severed nerve offered immeasurably more than either a staged procedure with stretching of the nerve, or a grafting procedure. To accomplish a repair with any hope of satisfactory regeneration, the damaged portion of the nerve must be removed until normal fascicles are observed in the cut ends. This frequently leaves a considerable gap between the ends to be repaired. It was soon apparent that in lesions below the middle third of the leg, a local dissection did not furnish sufficient slack to accomplish a repair of defects that measured 4 or 5 centimeters without excessive tension at the suture line.

At first, additional slack was obtained by extending the incision along the medial aspect of the leg as high as the medial condyle of the tibia, the gastrocnemius muscle was retracted posteriorly, and the tibial origin of the soleus muscle was completely severed allowing a digital exploration of the popliteal space from below. Since by this method an important part of the mobilization was not accomplished under direct vision, it was soon abandoned except in an occasional case. In one instance, however, this method was combined with an exploration of the popliteal space from above by continuing the incision along the medial aspect of the knee and lower thigh, and by retracting the medial hamstring tendons posteriorly.

While it is possible to mobilize the nerve in the above manner, it is more difficult than the method finally adopted as routine for extensive dissection of the tibial nerve. This method has been described in a communication (from Ashford General Hospital) by Allbritten² and is similar to that described by Fahlund.³ Its advantage lies in the direct exposure of the nerve from ankle to thigh. The incision extends along the medial aspect of the lower third of the leg and the posteromedial aspect of the middle and upper thirds of the leg, curves to the medial aspect of the popliteal space, and then continues to the posterior aspect of the thigh. The nerve is

approached by turning back the popliteal flap of skin and separating the heads of the gastrocnemius muscle as they insert into a common central raphe. The soleus muscle is then either split longitudinally or severed at its tibial origin, and the nerve exposed. In the lower third of the leg the narrow strip of Achilles tendon which overlies the nerve can be alternately retracted posteriorly and medially. The nerve is thus exposed from ankle to thigh. The slack is obtained by displacing the nerve posteriorly in the region of the popliteal space. The proximal cut end of the nerve can then be drawn down with the knee flexed and the thigh extended. The repair of the cut ends is accomplished with fine silk or tantalum wire sutures approximating the neurolemma. Preferably the site of repair is not covered by a tantalum cuff. Occasionally, it is necessary to transplant the nerve superficial to the soleus muscle or into the subcutaneous tissue to bridge the more extensive gaps. Even with this extensive exposure of the nerve, it is seldom that defects which measure more than 12 to 14 centimeters can be repaired without excessive tension. When the lesion of the nerve is in the upper third of the leg, the popliteal space, or the lower third of the thigh, it is unnecessary to mobilize the nerve in the middle and lower thirds of the leg, as little or no additional length will be obtained from below.

Postoperatively, some type of immobilization that maintains a minimum of tension at the suture line is required for at least 3 weeks. In many cases a cast from the upper thigh to the toes with the knee flexed at right angle is sufficient. Occasionally, it is advisable to limit hip motion by applying a unilateral hip spica with the thigh in mild extension and the knee flexed.

SUMMARY

A series of 109 cases of injury to the posterior tibial nerve is presented.

The disability that follows posterior tibial nerve injury is emphasized.

Certain technical aspects of the operative repair are discussed.

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THE PLACE OF COLOSTOMY IN PRESENT DAY SURGERY

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COLOSTOMY is the establishment of an artificial opening in some portion of the colon for the purpose of diversion of the fecal stream. Regardless of its type, location, number of openings, or duration, the purpose of this artificial anus is to divert the ever-present fecal current. With this purpose kept in mind, one is able to evaluate more critically indications and results of this procedure.

HISTORICAL NOTE

As a surgical procedure colostomy ranks with a large number of other surgical measures which have been in use for well over 200 years. The first successful surgical decompression of the colon was performed in 1776, by Pillore, of Rouen, who ignored the advice of several colleagues and performed a cecostomy in the right lower quadrant of the abdomen. His patient did well for 2 weeks but died at this time from small bowel obstruction due to a large quantity (2 pounds) of mercury administered as a purgative. The case was completed by autopsy, and the obstructive lesion in the rectum was demonstrated. It is interesting to note that in both the indications and the technical performance the management of this earliest recorded case compares favorably with the modern methods of treatment.

In 1793, a 3 day old child with imperforate anus was subjected to left inguinal colostomy by Duret. This patient lived to be 45 years of age. From that time forward a number of surgeons who were endowed with courage as well as skill performed more and more frequently surgical openings of the large bowel. The majority of these earlier cases during the eighteenth century were far advanced cases with malignancy, obstruction, or stricture. The mortality was indeed high, but in view of the previous hopeless outlook the results were gratifying.

THE EARLIER USE OF COLOSTOMY

At the beginning of World War I colostomy had become well established in civilian surgical practice. Accepted opinion, however, did not indicate that it would find a field of usefulness in military

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surgery. Consequently, during the early years of the war strict conservatism and non-intervention were the rule in the treatment of abdominal injuries. The mortality ranged from 70 to 95 per cent. As the conflict progressed, a change of concept became necessary, and colostomy was performed in more and more cases by both British and American surgeons during 1917-18. Even then, colostomy was reserved for the more seriously injured patients. These had extensive wounds of the colon and formed an unfavorable group, giving a high mortality rate. Some men even voiced the opinion that it was deleterious. It should be remembered, however, that no control group was available since the poorer risk patient was almost certain to be selected for its use.

USE BETWEEN WORLD WAR I AND WORLD WAR II

In civilian surgical practice in this era the indications for and use of colostomy were broadened to no great extent. It was still a procedure which was primarily restricted to use in malignancies. The inclusion of several methods is noted, namely, the Mikulicz-Paul procedure and Rankin's method. Colostomy was not generally advocated for trauma, since conservatism of the earlier war years was practiced by the majority of surgeons. This may have been to some degree due to the unfavorable comment of certain British authors.

COLOSTOMY IN WORLD WAR II

The attitude toward colostomy in World War II is an interesting contrast to the attitude toward it in World War I. Its life-saving properties were recognized early, and its employment in connection with exteriorization of damaged segments of bowel was responsible for saving thousands of lives. This change can fairly be regarded as one of the most important advances in the management of abdominal trauma in the recent conflict.

During the raids on London in 1940-41, colostomy with and without exteriorization of bowel was used liberally by British surgeons in the treatment of civilian casualties. The success of the similar technic for the management of malignancies, coupled with the high mortality associated with immediate repair of colon injuries, was doubtless responsible for its almost universal acceptance. A short time later surgeons of the British Army in the Middle East used colostomy for wounds of the colon with exceptionally good results. Concurrent with this experience there began to appear suggestions for the prevention of complications and conditions which made closure difficult.

With the entry of this country into the war, the adoption of this method of treatment by American surgeons was rapid. In late 1945, an order from the Office of the Surgeon General directed that loop colostomy be employed in large bowel injuries. Thereafter, surgery of the colon was based on three general principles: (1) exteriorization of damaged segments of bowel to avoid intraperitoneal contamination; (2) complete diversion of the fecal stream away from distal wounds of the colon and rectum by proximal colostomy; and (3) incomplete diversion of the fecal stream for gaseous decompression and possible future complete diversion by colostomy.

Considered practically, the management of large bowel trauma was carried out in three separate military zones: the field, the zone of communications, and the zone of the interior. The majority of colostomies were performed in forward areas, with aftercare and definitive treatment or closure occurring in the zone of the interior.

A comparison of mortality following colostomy in the early period with that in the period between the two wars and during World War II is of interest. From the middle of the nineteenth century a steady decline in the death rate attributable to colostomy of all kinds has been noted in numerous statistical reports. In 1853 and 1873, mortalities of approximately 50 and 30 per cent respectively were given by separate authors. In 1903, Tuttle collected 255 cases, with 8 deaths and a mortality of 3.1 per cent. As would be expected, the mortality rate increases markedly in the presence of obstruction. Certainly, some considerations for the primary condition for which colostomy was performed is necessary. From the turn of the century until the late 1930's mortality rates varying from 0.0 per cent to 13.4 per cent (average 4 per cent) were given by divers authors. A representative section of mortality following colostomy in World War II was afforded by replies to a questionnaire sent out to 45 hospitals in the zone of the interior during the winter of 1945-46. Of 2,470 patients submitted to colostomy overseas, 180 had been treated by closure in overseas theaters of operations, 188 had not yet received closure, and 2,102 had been treated by closure in the zone of the interior. Multiple operations were necessary in 150 cases, so that the whole clinical experience embraced 2,252 operations. There were 11 deaths in the series, a mortality of approximately 0.5 per cent.

One might contend that the results of such a large series as the above cannot be truthfully compared with previous figures in which many indications other than trauma were included. It is the opinion

of the author, however, that such a comparison is even more significant inasmuch as trauma of the colon or rectum is almost invariably followed by gross fecal contamination and that in the light of this hazard the mortality in these cases is lower than in those series including elective colostomy, and commands close scrutiny.

COLOSTOMY IN CURRENT SURGICAL PRACTICE

When we consider the place of colostomy today in general surgical practice as well as in the more definitive surgery of the colon and rectum, we find an ever-broadening field of application. From its earliest employment in poor risk patients, through war experiences and alternating periods of enthusiasm and pessimism, use of this procedure through demonstrable minimal mortality has at last assumed its rightful place in our surgical armamentarium: an extremely useful tool for the reduction of both morbidity and mortality in a large number of surgical and medical disease states.

The present indications for use of colostomy as a treatment for trauma of the colon and rectum are free and unlimited. The performance of an occasional unnecessary colostomy is more than offset by the striking reduction in death rate following large bowel injury. Colostomy, now as before, enjoys wide popularity as a palliative procedure in the management of large bowel malignancy with and without obstruction. Diversion of the fecal current before or concurrent with bowel resection is practiced by many surgeons. Certainly, colostomy has its greatest applicability in the presence of any obstructive process of the distal sigmoid colon, rectum or anus.

The etiology of obstruction may lie in embryologic maldevelopment such as imperforate anus or congenital atresia of the rectum.

Benign or malignant neoplasm in the lower large bowel is an indication for the construction of an artificial anus, as well as obstructions of mechanical origin. It affords accessibility to this region for the implantation of radioactive material, which might otherwise be difficult and require resort to external irradiation.

In the management of diverticulitis colostomy is frequently of great benefit and in many cases will tip the scales in favor of a patient chronically ill from infection and malnutrition.

Rectal strictures as the result of lymphopathia venereum, gonorrheal proctitis, endometriosis, or chronic infection may require proximal colostomy for decompression and in order to allow subsidence of edema and purulent discharge.

In extensive perirectal suppuration, abscesses, and fistulas one may list colostomy as a prerequisite for management and eventual cure. This includes extensive cellulitis and gangrenous periproctitis as well.

Extrinsic compression by extra rectal growths is also an indication rather infrequently encountered.

Incontinence as a result of *tabes dorsalis*, previous injury, neurologic injuries or operations can be obviated, and the patient's life made more bearable by a proximal opening in the colon.

The treatment of incurable rectosigmoid procidentia includes colostomy.

As in the past, the problem of the patient's acceptance of colostomy is still with us; a great many people inevitably manifest an aversion to the artificial anus. This aversion may be partially due to inadequate explanation or lack of sufficient instructions in care. With present day methods of management, colostomy has lost much of the former inconvenience and distastefulness. The better selection of a site, regularity and type of diet, and systematic irrigation with the use of specially designed pads or belts has done much toward establishing normal control and comfort. In lieu of the primary condition which served as an indication for colostomy, the patient is given partial or complete relief with only slight added inconvenience. In many cases the prospect of future repair will do much to improve psychic disturbances, if present.

TYPES OF COLOSTOMY

The type of colostomy selected will depend upon several factors. The primary consideration is the question of whether the surgeon desires a complete or incomplete diversion of the fecal stream. This decision is usually dictated by the primary pathology. Conditions in which subsequent passage of a fraction of the fecal current into the distal bowel might be deleterious or definitely contraindicated (such as fistula, extensive infection or complete obstruction) obviously require the complete type. For simple gaseous decompression incomplete colostomy may suffice.

The condition of the patient at operation, the experience of the operator, the location of the bowel pathology and the time factor (as in war surgery) all further influence selection of technic.

Cecostomy is frequently a valuable and much needed measure; however, it does not function satisfactorily to divert completely the stream. This may be accomplished by a complete exteriorization

as in other types of colostomy more distal. It is performed by a right rectus or grid iron incision approaching the cecum at its junction with the ascending colon. The freed-up bowel is delivered into



Fig. 1. A well functioning left flank colostomy, incomplete type, stomas touching.

the incision and catheter drainage instituted. In exteriorization an opening is made through a tenia.

Appendicostomy may be mentioned here only to say that this procedure does not constitute the establishment of a true colostomy. This procedure enjoyed considerable popularity in earlier surgery but is rarely used today in place of other more adequate methods. It does not exclude the large bowel, place it at rest, or afford adequate decompression.

Loop colostomy is of two types: complete and incomplete, or so-called knuckle colostomy. In the former a loop of large intestine

is drawn into the wound, an opening made in an avascular space of the mesentery, and several of the smaller vessels in the mesentery ligated. The opening in the mesentery is made of sufficient size to

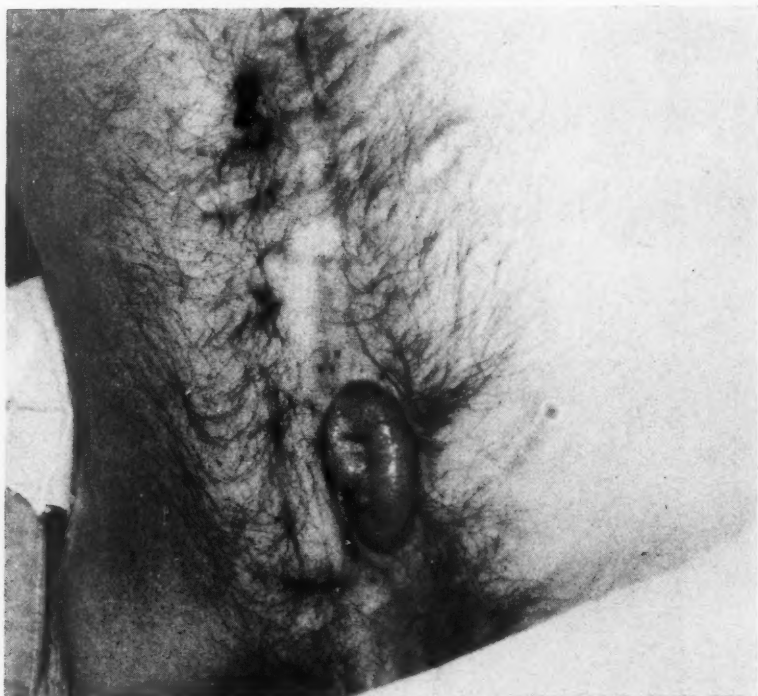


Fig. 2. Sigmoid colostomy, Mikulicz type, with spur.

permit approximation of the parietes beneath it, yet not to interfere with the blood supply of the adjacent mesentery. The skin is closed around the two limbs of intestine so that gut bridges a portion of the skin. Vaseline gauze is applied around the exteriorized intestine and rubber tissue over the margins of the wound. The intestine is then opened after a period of 48 hours or more. Knuckle colostomy is performed by pulling a loop of large intestine into the wound and anchoring it securely to the peritoneum with interrupted sutures, and subsequently to the skin to prevent recession into the abdominal cavity. If the wall of the bowel is extremely thin due to distention, the peritoneal sutures are omitted since leakage and peritonitis may result. The wound is small enough that additional sutures are unnecessary. The colon is opened 48 to 72 hours later.

When incising the intestine of a complete loop colostomy, one has the choice of two procedures. Simple incision longitudinally through a tenia coli will afford incomplete diversion. If, however,



Fig. 3. Ileo-cecostomy, with prolapse of small bowel. This is not a recommended procedure and is difficult to care for.

the limbs of the loop are completely divided on either side of the bridge of skin, complete diversion will result. This is spoken of as a modification of the Devine type of colostomy.

Transverse colostomy is an additional modification of the loop colostomy in which the knuckle of colon does not have peritoneum, fascia, or skin intervening beneath the loop, but is elevated by a glass rod. The outer limits of the incision are approximated in layers centrally until the knuckle is reached.

In the Mikulicz exteriorization procedure the involved segment of bowel is mobilized and delivered into the wound and the mesenteric blood vessels and lymphatic structures left intact. With traction maintained by an encircling loop of gauze a row of interrupted sutures is placed some distance from the lesion so that at least 6 cm. of the intestine are joined. A second row of sutures is then placed in such a manner that the antimesenteric borders are approximated. The abdominal wall is then closed snugly about the mass, which is

encircled by vaseline gauze. Crushing clamps may then be applied to the 2 limbs of the loop thus formed close to the skin and the loop excised. Catheter drainage of the proximal stoma may be insti-

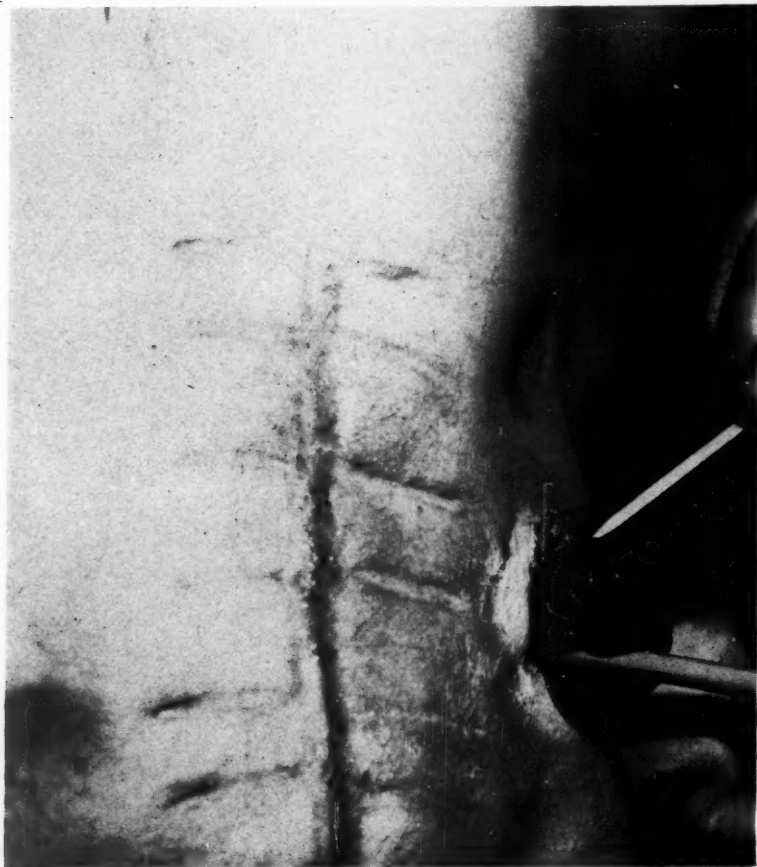


Fig. 4. Retraction of stomas with herniation of redundant mucosa and formation of accessory openings—a complication to be avoided by securing adequate bowel in loop.

tuted for a short time. This type of colostomy has several advantages. First, it is accomplished rapidly and is the safest procedure in the hands of the occasional or inexperienced operator. Secondly, it allows immediate excision of that portion of the gut which is diseased or injured. Lastly, closure may be easily accomplished by cutting through the spur with a crushing clamp or enterotome. Care must be taken that the spur is of sufficient length so that loops of

the small bowel are not included in the limbs of the colostomy or perforation of the wall of the gut produced.

Special types of colostomy are occasionally used by men who have devised them or have become experienced in their use. Two that might be mentioned are the Pauchet and the one employed more recently by Wangensteen, in which the stomas are made to point away from each other.

GENERAL CONSIDERATIONS

As a general rule the site preferred is the flank. The right sided colostomy is not as good as other locations. One should never use the cecum or ascending colon if at all avoidable. This is especially true when considered in conjunction with ileostomy, since the latter presents difficult problems of fluid balance, malnutrition, and irritation of the surrounding skin. Transverse or descending colon are the regions best suited.

In the technical performance of colostomy one should strive to avoid the pitfall of allowing retraction of the stoma and the herniation of gut or other abdominal contents. It must be remembered that there is an innate tendency for exteriorized gut to retract. An adequate portion should therefore be drawn into the wound to allow for this reaction. If the abdominal wall is not closed sufficiently around the large bowel, a protrusion or telescoping outward of the gut may result and pose a difficult problem in care. True incisional hernia may also be the result of leaving large fascial defects. In temporary colostomy these do not merit much alarm as a repair can be affected simultaneously with closure of the bowel opening. However, in permanent types it is not desirable to have to do a second operative procedure for these conditions.

Small bowel obstruction due to incarceration of a portion of small intestine between the colostomy and the parietal peritoneum is a serious complication. This may be avoided by inserting a purse-string suture between the bowel and lateral peritoneum in the case of the sigmoid.

For complete diversion of contents of proximal bowel one must employ a colostomy which will successfully prevent the passage of any material between stomata. Incompletely divided loop colostomies will not accomplish this. Probably the Devine colostomy will prove to be the most satisfactory in this respect. The stomata must not touch.

More serious complications include gangrene of the loop due to

pressure of the wound or inadequate blood supply. The great danger in this eventuality, of course, is general peritonitis. The main cause of operative death is and always has been peritonitis. Stenosis of the orifice is occasionally encountered. Phlebitis of the mesenteric vessels, while infrequent, has been known to occur.

General surgical therapeutic measures such as regulation of fluid balance, maintenance of adequate food and vitamin intake, and the use of chemotherapy are always employed. Since the function of the right colon is largely the absorption of water the more distal the opening the more solid the feces become and the less difficulty experienced in fluid regulation.

The use of sulfonamide compounds of low solubility, absorption and toxicity such as sulfasuxidine (succynylsulfathiazole) and sulfathalidine (phthalylsulfathiazole) is indicated in both pre- and postoperative treatment. If these compounds are used with resultant marked decrease in intestinal bacterial count, the synthesis of vitamin K by these bacteria may be diminished and over a period of time give rise to a hemorrhagic diathesis. It is well to administer oral preparations of vitamin K along with these drugs. The use of other sulfonamide compounds, penicillin, and streptomycin is dictated by choice of the surgeon.

The selection of a colostomy diet is an important measure in enabling the patient to maintain control and in establishing the formed, regular stool. Most colostomized individuals soon discover the regime best suited to their type of opening. The additional problems of irritation of the skin, odor, and the fitting of a proper belt all require the surgeon's help and instructions.

CLOSURE OF COLOSTOMY

This is of 2 types: extraperitoneal and intraperitoneal. The extraperitoneal type of closure has the advantage of not entering the peritoneal cavity and thus avoiding possible contamination and infection. There are decided disadvantages to this procedure, however. The closure may break down with the formation of a fistula which requires a second operation. The danger of acute angulation of the gut and incomplete obstruction is also present. It may be desirable to obtain a better exposure of the loop, and this is impossible with extraperitoneal technic.

Whereas the intraperitoneal closure does theoretically allow contamination of the general peritoneal cavity with possible risk of peritonitis, recent experience with large numbers of closures by this technic have not shown that this is a frequent complication. Ade-

quate exposure with freeing of the bowel is performed, and a thorough inspection can be carried out. Lateral suture, transection and end-to-end anastomosis, or resection of intervening segments of bowel in the case of multiple colostomies with end-to-end anastomosis may all be executed. In the intraperitoneal closure technic, a more thorough closure of the abdominal wound including peritoneum can be accomplished.

Operation should not be undertaken until (1) the nutritional status is restored to normal or to a level on which surgery will be safe; (2) the healing of associated injuries has advanced to a stage at which ambulation is possible; (3) fecal fistulas have been healed for at least 8 to 12 weeks; and (4) the skin about the colostomy is in optimum condition.

Immediate preparation for operation includes the measures enumerated above as well as local cleansing by frequent irrigation, the use of some one of the sulfonamide preparations, vitamin K, and paregoric just before operation. It is desirable that the chloride, protein and vitamin C levels of the blood be within normal range. Roentgenograms for foreign body, obstruction, or other abdominal pathology are advisable preoperatively.

All methods of anesthesia may be used with the exception of local infiltration. Fractional instillation of an anesthetic into the spinal canal is the most favored method.

Statistics from World War II show that of 2,102 colostomies closed in the zone of the interior hospitals the method of approach was not stated in 289, the intraperitoneal technic was used 1,055 times (58.2 per cent) and the extraperitoneal 758 times. The method of closure employed in the above cases was stated in only 1,324 of the 2,102 operations. End-to-end anastomosis was employed in 642 cases (48.2 per cent), side-to-side in 15 cases, the Pauchet in 22 cases, and other measures, including spur crushing and closure in 667 cases (50.4 per cent).

The postoperative regimen following closure is simple. Nothing is given by mouth for 48 hours when fluids and a soft diet are allowed. Fluid balance and nutrition are maintained by parenteral administration. Gastric or intestinal suction may be used when distention is feared. Chemotherapy is continued for 5 to 7 days afterward. Early ambulation is not contraindicated.

Of the 2,102 cases of closure of colostomy in military personnel, 11 deaths are known to have occurred, a percentage of 0.5. These

were equally divided between the intraperitoneal and extraperitoneal groups.

SUMMARY

A survey of the use of colostomy during a period of 200 odd years indicates a possible division of attitudes concerning it into several fairly well defined periods: the earlier, hastily performed and occasionally bungling performances by the daring men who pioneered large bowel surgery; the period of development of technic up to and through the antiseptic—aseptic eras of surgery; the alternating enthusiasm and pessimism of World War I and the immediate postwar period; the gradual evolution of colostomy as a definitive surgical procedure between the two World Wars; the very extensive experience in World War II; and the evolution of present day concepts.

Certain definite indications now exist for the performance of colostomy, and the field of application is becoming broader each year. Depending upon the primary pathologic condition, selection of type and duration must be suited. If complete diversion of the fecal stream is desired, complete colostomy with separate stomata is required.

The establishment of colostomy and its subsequent closure can be accomplished with a mortality which compares very favorably with that of appendectomy for a simple acute appendicitis and similar surgical conditions which are generally assumed to have quite low mortality.

Careful adherence to the principles of aseptic surgical technics, good pre- and postoperative care, the use of combined chemotherapy and the adequate instruction of the patient regarding aftercare will continue to make colostomy a safe and useful surgical procedure with a minimum of morbidity and inconvenience.

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TRANSVERSE ABDOMINAL INCISIONS

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ALTHOUGH transverse abdominal incisions have been advocated^{1,6} over a period of many years, there has been a hesitancy on the part of the majority of surgeons to give this type of incision a fair and adequate trial. At the Grady Memorial Hospital, the vertical incision has been practically abandoned in favor of the transverse approach for abdominal operations of general surgery. The facility of entry into the abdomen, the remarkably wide exposure secured without sustained retraction, and the ease of closure under minimal wound tension make the incision particularly desirable from a technical standpoint. The relative absence of wound pain, and the patient's freedom from fear of coughing and deep breathing make the incision an adjunct to the patient's early physical and psychologic recovery.

The principal objections offered by surgeons who are not familiar with transverse incisions are for the most part without clinical foundation and in many cases are the antitheses of the actual advantages of the approach. The fear of cutting the rectus muscles is foremost in the minds of many operators. If the rectus sheaths are carefully sutured the muscles will heal by the formation of a scar which is not unlike the linear inscriptions that are characteristic of this muscle. Interference with the blood and nerve supply is negligible, hence a strong postoperative wound may be anticipated. It has been found that the time for opening and closing the incision has not been increased by the utilization of the transverse approach.

It has been shown that the lateral pull exerted on the suture line of a vertical incision is proportional to the square of the incision's length.³ This lateral force represents the combined actions of the flat abdominal muscles, the external and internal oblique, and the transversus abdominis. Sloan² has demonstrated that a force of about 30 pounds is necessary to approximate the wound margins of a 3 inch vertical wound in the average adult under light anesthesia. He noted also that a force of 50 pounds is exerted on the suture line of a 4 inch vertical wound. It should be emphasized that as the length of the vertical incision is increased the pull on the suture line is increased geometrically. Obviously the acts of coughing and retching would place still more stress on the abdominal wound. The

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lateral pull mentioned above is many times greater on a vertical wound than on a transverse incision.

The cosmetic results following transverse incisions on the abdominal wall are far superior to those of vertical incisions. The explanation of this lies in the fact that the incision roughly parallels Langer's lines of skin cleavage.

The location and direction of the incisions which have been found useful are demonstrated in Fig. 1, and only a few additional points need be stressed. Incisions requiring the division of only one rectus

VARIOUS TYPES OF TRANSVERSE INCISIONS

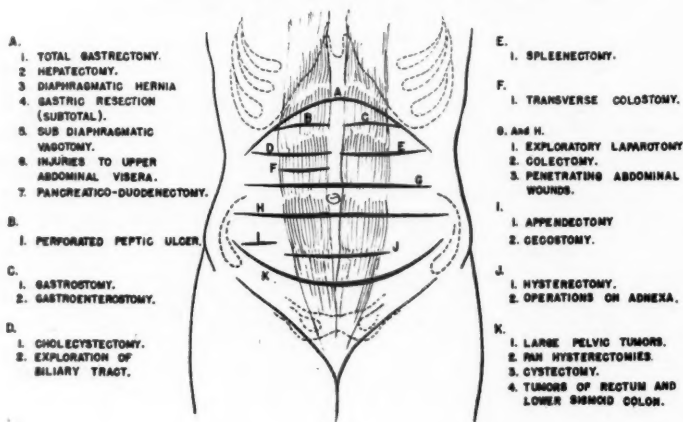


Fig. 1

muscle have been used to great advantage in cholecystectomy, splenectomy, gastrostomy, gastroenterostomy, and transverse colostomy. In the latter operation, the incision, running as it does parallel with the transverse colon, prevents kinking and twisting of the mesentery when the colon is pulled through the wound. There is always a rotation of the mesocolon incident to the use of vertical approaches for transverse colostomy.

The straight line incision made an inch above or below the umbilicus is often used for exploratory celiotomy. This incision has proved to be admirably suited to operations for intestinal obstructions. The length of the wound depends entirely on the range of exposure needed, and the surgeon should not hesitate in extending the incision to the mid-axillary lines if necessary.

The incision may be curved sharply or gently above or below the umbilicus in order to gain better access into the extreme limits of the upper or lower abdomen. These incisions then allow remarkably good exposure of the subdiaphragmatic areas or the depths of the pelvis.

The technic of making and closing a transverse incision is simple, and readily lends itself to a wide range of applicability. The details are similar for both the straight and curvilinear incisions. Vertical scratch marks made on the skin with the point of a scalpel, at right angles to the incision, insure an accurate closure. These landmarks are particularly useful in closing the curvilinear wounds. The initial incision is extended through the skin and superficial fascia. Lately electrocoagulation has been used for small bleeding points and the results have been proved to be satisfactory. Its limitations, however, must be strictly observed, and its use for the control of larger bleeding vessels is condemned; fine non-absorbable ligatures, either cotton or silk, are recommended for bleeders too large for electrocoagulation. Dry towels sutured to the subcutaneous tissues of the wound margins offer maximum protection from skin contamination. When the anterior rectus sheath has been exposed, the abdominal cavity is entered through a small transverse incision made in the linea alba and peritoneum. The rectus muscle, including its sheaths and the peritoneum, is then divided. Bleeding points are clamped as they are cut. The location of the epigastric vessels is anticipated, and they are usually clamped and ligated separately. Additional bleeding from the cut ends of the rectus muscle is minimal, there often being only two or three bleeding points which require ligation. The incision is developed laterally, separating the fibers of the flat muscles by sharp dissection. It is believed that less trauma is inflicted by this method than by forceful separation of the fibers by the fingers or by blunt instruments. Care is taken to avoid injury to the lower intercostal nerves although no appreciable damage is noticed when such a nerve is sacrificed.

Closure of the wound is greatly facilitated by flexion of the patient's trunk, thus permitting the wound to fall together. The closure can then be accomplished without tension. Interrupted cotton or silk sutures are used for the closure of the peritoneum; such a closure is more secure in that there is minimal tissue reaction^o about the suture line. In the upper abdomen the transversalis fascia, the peritoneum, and posterior rectus sheath are closed together with interrupted sutures. There is nothing gained by attempting to suture the cut ends of the rectus muscles. It is noted that the muscle ends are satisfactorily approximated by accurate suture of the

rectus sheaths. A few loosely tied sutures are employed to close the fascia of the lateral muscles. The subcutaneous tissues and the skin are each closed with fine cotton or silk sutures.

SUMMARY AND CONCLUSION

The transverse incision has enabled surgeons to utilize to better advantage those things which are believed to constitute good post-operative management. Since the stress upon the transverse incision is definitely less than that upon the vertical incision, the likelihood of wound disruption is decreased. This safer incision allows the maximum benefits of early ambulation to be gained, and the patients have been less hesitant to accept this regimen. Respiratory complications have been reduced. Local wound complications in both elective and emergency cases have been diminished. There is little doubt that the convalescent period of the surgical patient is not only shortened but made more comfortable.

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THE SURGICAL TREATMENT OF GROWTH DEFORMITIES OF THE MANDIBLE

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GROWTH abnormalities of the mandible produce some of the most disfiguring deformities of the face. In general, four types of growth disturbances of the lower jaw may be noted:

1. Mandibular protrusion
2. Mandibular retrusion
3. Unilateral hypertrophy
4. Unilateral hypoplasia.

Each of these groups is characterized by a disfiguring deformity of the mandible and consequently of the entire face. Probably each of these groups is initiated by a developmental anomaly of the main growth center of the mandible, the condyle.

The growth of the mandible is of the appositional type which proceeds primarily from an area of cartilaginous activity at the head of each condyle. Elongation of the ramus of the mandible is effected by the proliferation of bone at the condylar head. If one condylar area through disease or injury fails to produce as much bone as the opposite side, asymmetry of the face will result. A similar effect will be produced by one condylar area responding to an excessive degree to growth stimulus, producing a hypertrophy of one condylar and ramus area, with a relatively normal condyle and ramus existing on the opposite side. In addition, remodeling of the surface of the jaw proceeds by resorption and deposition of bone about the periphery of the structure.

MANDIBULAR PROTRUSION

The etiology of mandibular protrusion is not clearly understood. It is well known that a specific type of protrusion occurs in acromegaly, but the great majority of prognathous patients do not present clinical signs of pituitary hyperactivity. There is some evidence to indicate that a genetic trend toward such a maldevelopment may exist in certain families, as has been seen in the Hapsburgs. It seems that this deformity may not be an acquired char-

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acteristic but may represent an inherent tendency of the mandible to grow to an unusual extent. A rather frequent type of acquired prognathism is that associated with bilateral cleft lip and cleft palate in which the premaxilla has been removed. The loss of the maxillary anterior segment, and frequently the disturbance in growth of the entire maxilla secondary to surgical repair of the cleft, results in a relative prognathism which may be of extreme degree. In general, however, prognathism may manifest itself as an idiopathic increase in the size of the mandible unassociated with any other recognizable abnormalities.

The objectives of treatment of this condition are twofold: (1) To improve the occlusion of the teeth and thereby improve masticatory function, and (2) to correct the facial deformity. Two general types of treatment of prognathism exist: (1) the orthodontic and (2) the surgical. The orthodontic treatment relies for its effects on the movement of the teeth of both maxilla and mandible to a more relatively normal relationship to each other. Usually, orthodontic treatment is not effective in altering the size or shape of the jaws; however, in the less severe cases good efficiency of the masticatory apparatus may be attained with but little improvement in the profile or facial contour. The surgical methods of treatment produce their effects by sectioning the mandible at some point, moving the jaw distally to a more nearly normal relationship to the maxilla and adjusting the occlusion after surgery by orthodontic means. Modern surgical approaches to the mandible in treating this condition may be divided into three groups:

1. Bicondylar resection
2. Resection of the body of the mandible
3. Osteotomy of the ascending rami.

Bicondylar resection, first described by Berger of Germany in 1897, consists in the removal of both mandibular condyles with consequent destruction of the temporomandibular articulation. It is evident that the removal of the condyles bilaterally will allow the mandible to move upward and backward to overcome the deformity. This procedure is rarely performed at present because of the destruction of the temporomandibular articulation, but in certain instances it may be of value and should be considered.

Blair in 1897 performed the first bilateral section of the body of the mandible. This procedure consists in the removal of a previously measured wedge of bone from either side of the horizontal portion of the mandible and a backward displacement of the anterior fragment to reduce the prognathism. The cut ends of the

mandible are then held in proper apposition by the use of a previously fitted splint (figs. 1 and 2). This procedure actually reduces the size of the mandible by the amount of bone removed from each side and continues to be a useful procedure. Refinements in technic permit the removal of bone without severing the mandibular vessels or the mandibular nerve, thus avoiding the possibility of permanent paresthesia of the lower lip.

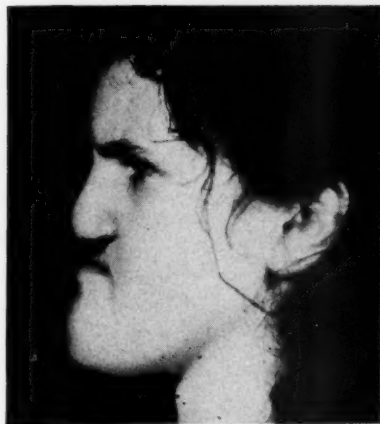


Fig. 1. Mandibular protrusion associated with bilateral cleft lip and cleft palate.



Fig. 2. Treatment of protrusion by bilateral excision of bone from the body of the mandible. The upper lip and nose require further surgery to produce the best cosmetic effect.

Osteotomy of the ascending rami is concerned with methods of producing a bilateral section at various levels of the rami, shifting the mandible backward along the line section followed by immobilization of the jaws until healing occurs. This procedure, first utilized by Babcock in 1907, has since been used with modifications by many surgeons. Blair utilized a pedicle needle to pass a Giglisaw thereby permitting subcutaneous section of the bone and avoiding conspicuous scarring of the face. The main advantage of the method is that a clean osteotomy wound results since the mouth is not opened into. There is no sacrifice of bone, no change is made in the mandibular arch and no teeth are sacrificed. The disadvantages lie in the fact that the pull of the temporal and external pterygoid muscles tends to separate the bone ends and non-union may result. Occasionally, open bite is associated with the non-union and will require repositioning of the mandible and a bone graft to stabilize the jaws.

In 1939 we utilized a similar method which had the additional advantages that a minimal amount of bone was cut thus producing minimal trauma and which was not subject to operative corrections in the event of non-union. The ramus was sectioned on each side between the posterior border and the sigmoid notch thus producing a bilateral fracture beneath the condylar neck (figs. 3 and 4). This permits the jaw to be moved backward as desired and, of all the approaches with which we are familiar, is perhaps the simplest.



Fig. 3. Mandibular protrusion of unknown etiology.



Fig. 4. Treatment of protrusion by bilateral subcondylar osteotomy. Note small incisions necessary in this approach.

We have produced our best results by working in conjunction with an orthodontist who places arches on both upper and lower jaws, banding sufficient teeth to assure stability in the appliance. The teeth may be moved preoperatively to a position where good interdigitation will be attained following mandibular section. After the osteotomy, the arch bars are used to fix the jaws firmly in the desired position. Following healing of the mandible in the new position the orthodontist again utilizes the appliances on the teeth to adjust the occlusion to the best possible state. This eliminates the necessity for grinding the occlusion in the majority of patients and permits attaining a more satisfactory chewing surface. The combined orthodontic-surgical approach is capable of producing brilliant results in selected cases.

There is a small group of patients exhibiting prominent chins in which the occlusion is not particularly faulty. These patients exhibit an increase in size of the mental portion of the mandible pro-

ducing a prominent chin. The treatment consists in the excision of the projecting portion of the chin by means of a sub-mental approach. Satisfactory results can be attained by removal of sufficient bone.

MANDIBULAR RETRUSION

In this condition the jaw fails to assume a normal position of prominence in the face. The most profound types of restricted growth of the mandible are seen in those individuals with bilateral



Fig. 5. Retrusion of the mandible due to growth deficiency.



Fig. 6. Restoration of normal profile by submental implantation of cartilage.

damage to the condyles as is produced in ankylosis. Since most of the downward and forward growth of the jaw is initiated at the condylar area, it is evident that disease or injury may upset the activity of this area and permanently restrict mandibular development. The treatment of these severe underdeveloped mandibles is difficult. Attempts have been made to move the jaw forward by bilateral section of the ramus. However, in a forward movement of the anterior segment, nearly all the powerful masticatory muscles are put under tension and stretch, and these exert a continuous pull on the anterior fragment tending to move the mandible back to its previous position. In addition, the forward movement of the mandible causes considerable separation of the bone fragments at the osteotomy site and is likely to lead to non-union. Attempts have

been made to lengthen the body of the mandible by tangential or "L" shaped cuts in the body holding the mandible forward in an advanced position until satisfactory bony union occurs. Since here the osteotomy is made anterior to the attachment of the masticatory

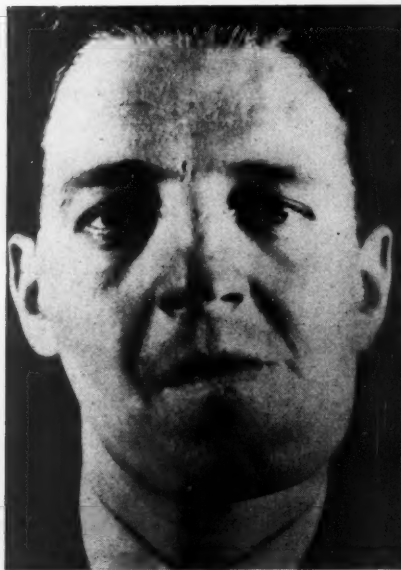


Fig. 7. Unilateral hypertrophy of the right mandibular condyle. Note the center of the chin has shifted to the left.

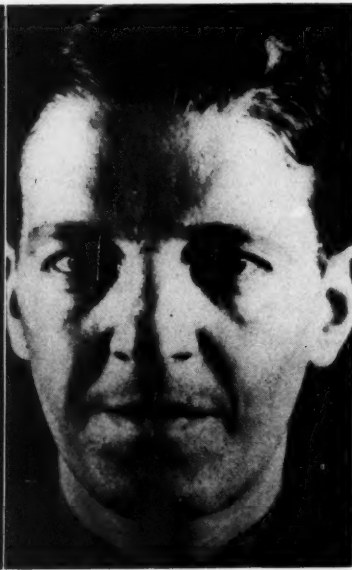


Fig. 8. Restoration of facial symmetry by excision of the right mandibular condyle and rotation of the mandible to the right.

muscle, with the exception of the infra-mandibular group, there is less tendency for the mandible to return to its previous dimensions. In general, however, this group of deformities presents many problems in treatment which have not been satisfactorily solved. In the more minor deficiencies suitable results are attained by building out the prominence of the chin. Obviously the extent to which this can be done is limited by the amount of soft tissue available in the submental area for closure of the soft tissue gap. Perhaps the materials most frequently used to build out the mental eminence are autogenous bone or cartilage which may be either as an isograft or an autogenous graft. We have used all these materials with satisfactory results. Bone from the iliac crest is suitably shaped for emphasizing the chin and may be wired to the mandible for firm fixation. The technic of these implants is simple. Through a small

submental incision a pocket of sufficient size to hold the implant is prepared along the anterior surface of the mandible. One should avoid damaging the mental nerves on either side, which provide the lower lip with their sensory supply. The implant of cartilage or bone, suitably shaped is then introduced into the pocket. It may be fixed to the mandible with a few sutures, following which the soft tissue wound is closed (figs. 5 and 6). Generally the soft tissue pocket prevents the graft from migrating without additional fixation.

UNILATERAL HYPERTROPHY

Unilateral hypertrophy of the mandible is associated with a growth disturbance of one of the mandibular condyles. A review of reported cases indicates that this disturbance is frequently present in the form of a cyst, osteoma or chondroma of the mandibular condyle. The disease is characterized by a slowly progressive, unilateral, painless increase in the size of the mandible associated with deformity of the face and malrelationship of the teeth. There is a deviation of the chin to the normal side and a characteristic crooked bite results. There may be some pain or crackling in the affected temporomandibular joint but in general the attention of the patient is attracted by the increasing facial deformity and the difficulty in chewing properly since the maxillary teeth no longer occlude functionally with those of the mandible. The treatment of the facial deformity consists in the excision of the diseased and enlarged condyle. This permits the mandible to be rotated to its normal position and facial symmetry is again restored (figs. 7 and 8). The restoration of satisfactory dental occlusion may be difficult to attain if the condition has persisted sufficiently long prior to treatment to permit some migration of the teeth. Here again, orthodontic treatment is utilized after surgery to produce the best attainable occlusion.

SUMMARY

Growth disturbances of the mandible produce profound deformities of the face. These deformities may best be treated by surgical means, frequently combined with orthodontia to produce the best cosmetic and functional results. The objectives of treatments which are the correction of the facial deformity and the restoration of the dental occlusion are best attained by this combined approach.

FRACTURES OF THE RADIAL HEAD

Associated with Chip Fracture of the Capitellum in Adults; Surgical Considerations

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FRACTURES of the head of the radius are common; they represent about 10 per cent of all forearm fractures. According to Murray,¹ fractures of the head and neck of the radius are the most common fractures involving the elbow.

Isolated fractures of the capitulum humeri have been considered rare lesions. Only a few over one hundred cases have been recorded, the first by Hahn² in 1853, after necropsy observation, and later by Kocher,³ who described "toruli humeri" in 1896.

Few references have been made to radial head fractures and concomitant similar traumatic lesions of the capitulum humeri. Milch⁴ reported an unusual case of this type in which the capitellar fragment was rotated and wedged into a fissure fracture of the radial head.

Watson-Jones⁵ stressed the frequency of radial head fracture with damage to the cartilage of the capitellum and classified three degrees of trauma: (1) bruising of the articular cartilage of the capitellum, (2) chip fracture of the capitellum, and (3) fracture of half the capitellum and adjacent part of the trochlea.

It is felt that sufficient emphasis has not been given to chip fracture of the capitellum associated with fracture of the radial head even though the lesion is common and often difficult to diagnose. The prognosis and treatment of a simple crack or undisplaced marginal fractures of the radial head often will be considerably altered if there is an associated chip fracture of the capitulum humeri.

MECHANISM OF INJURY

Although a history of the mechanism of injury in any fracture is often unreliable, it appears that a fall onto the base of the hand with elbow extended and forearm pronated is most frequently related by the patient. A fracture of the radial head, be it a fissure, marginal, or comminuted type, usually implies a severe impacting force being resisted by the immediately opposing surface—the capitellum of the humerus.

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In an individual with hypermobile elbow joints for which 10 degrees to 20 degrees of hyperextension is allowed, a fall with arms extended may predispose the capitellum to fracture. In this position the long axis of the radius approaches a right angle with the axis of the capitellum, and the breaking force applied to the stalk of the capitellum is maximal.



Fig. 1. Lateral x-ray view prior to pneumoarthrogram.

It is probable that the mechanism of capitellar chip fracture is slightly different from that of fracture of half the capitellum. In the former, the trauma from the radius is less direct. A shearing type force is applied to the articular cartilage of the capitellum as the patient's hand strikes the ground and the elbow is subsequently flexed, or when the trauma is received on the dorsal surface of the upper forearm the elbow is forcefully flexed from a partially extended position.

DIAGNOSIS

When a large segment of capitellum is displaced, the roentgenologic diagnosis is easily made. When a small segment of capitellum is displaced, however, roentgenographic visualization may be quite difficult. This may represent a fracture of only articular car-

tilage, but more often it represents a fracture of capitellar articular cartilage with a flake of bone.

Diagnosis of this chip fracture is difficult and often will be made only by an alertness to the possibility of association with fracture of the head of the radius. If the diagnosis cannot be established when the patient is originally examined, chip fracture may be suspected

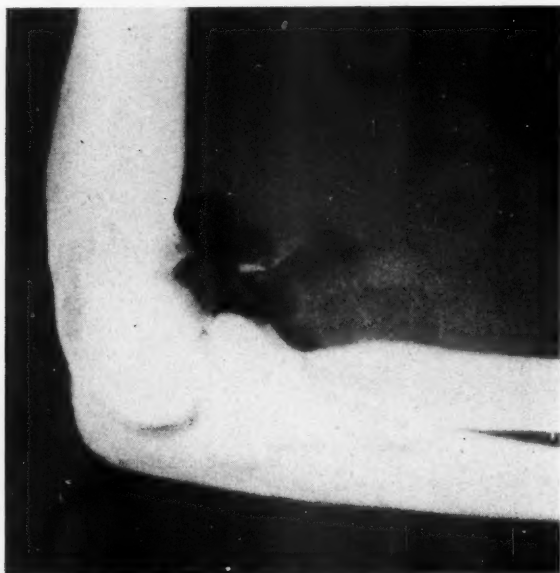


Fig. 2. Lateral view after injection of oxygen to visualize loose fragments.

in a patient in whom unusually slow recovery from radial head fracture cannot be otherwise explained. Pneumoarthrograms (figs. 1 and 2), performed in selected cases, may be helpful in roentgenographic visualization. Signs and symptoms of a loose joint body may also become manifest at a later date.

The differential diagnosis in late cases may be a source of considerable academic interest and discussion. The question of congenital, traumatic, degenerative, or developmental origin is always present concerning para-articular and intra-articular bone about a joint. Hence, osteochondritis dissecans of the capitellum, or other intra-articular region, is considered along with arthritic osteophytes, osteochondromatosis, traumatic ossifications or separations, and accessory and sesamoid bones.

SURGICAL CONSIDERATIONS

The elbow joint can be approached from the anterior, lateral, or posterior aspect. For good visualization of the radio-humeral joint, the anterior approach similar to Professor Henry's⁶ exposure of the antecubital fossa and shaft of the upper radius is preferred unless preoperative evidence is contrariwise, e.g., loose fragment in olecranon fossa.

The line of skin incision runs parallel to the medial border of the brachio-radialis muscle, being curved to the outside at the upper portion as an inverted hockey-stick. Deep fascia is split parallel, but one-half inch lateral to the cephalic vein.

The interval between brachialis and brachio-radialis muscles is a key to easy dissection, and after the loop of recurrent radial vessels has been located (fig. 3) presents an inverted "V" for easy upward blunt dissection. Fortunately, the branches of the (superficial) radial and the (deep radial) posterior interosseous nerves are overlapped by the brachio-radialis muscle and pass to muscles on the *lateral* aspect of the nerves. Hence, as Grant⁷ points out, the *medial* aspect of the nerves is the "side of safety" down to the supinator muscle.

For complete visualization of the anterior aspect of the elbow, the supinator muscle is detached near its insertion, the recurrent leash of radial vessels is ligated low, and the anterior terminal branch of the brachial profunda vessels is ligated high in the wound. With the elbow partially flexed, the lower lateral edge of the brachialis muscle is elevated and retracted medially along with the musculo-cutaneous nerve. The extensor muscle group and supinator, with branches of the radial nerve, are retracted laterally.

The joint capsules, fibrous and synovial, are loose with the elbow flexed and are opened as two separate layers for reasons given below. In cases where operation is delayed, this interval between capsular layers, which normally contains localized fat deposits and areolar tissue, is dense and adherent, and dissects with difficulty.

Redundant synovial folds are noted on entering the joint cavity. Care is exercised to preserve especially the crescentic fold between the head of the radius and the capitellum of the humerus.

Visualization of all three articulations of the elbow joint (i.e., articulations between (1) humerus and ulna, (2) humerus and radius, and (3) ulna and radius) and of the coronoid fossa is afforded by this exposure. The radial-humeral articulation (capitellum), or lateral hinge, is especially well seen, and pathology may

be noted as the joint is moved through all motions. In extension, the head of the radius is not in complete contact with the rounded capitulum humeri, and exacting inspection of the articular surface is made.

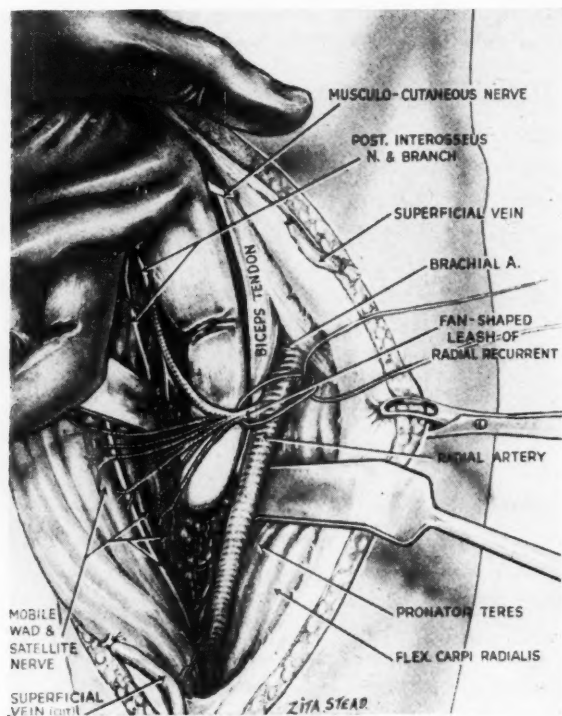


Fig. 3. Finding the fan-like leash. (Henry)

A loose fragment, if detached from the capitellum, has been noted most often in the coronoid fossa. If the capitellar fragment is incompletely detached, its position can be noted to change with passive joint movement, but it is difficult to wedge the fragment as a mechanical block between radial head and capitellum. The crescentic synovial fold occupying this angular interval may show tearing, fragmentation, fibrosis, or calcification, the latter being noted in old cases at the lateral edge where this semilunar-type septum merges with the fibrous capsule and is reinforced by the radial collateral ligament. With radial head-capitellar fractures, tissue strands of varying density are noted to join adjacent denuded articular surfaces.

If excision of the head of the radius is indicated, this can be easily accomplished with a sharp, thin-bladed osteotome as the forearm is supinated or pronated.

After excision of the radial head and removal of all loose joint bodies, exacting hemostasis is essential before starting wound closure. The initial step of closure is careful coverage of the stump of the neck of the radius in order that no denuded bone is exposed. A periosteal cuff has been recommended,⁵ but this has been found by us to be anatomically impossible if only the radial head is excised and the annular ligament with the fan-shaped supplementing radial collateral ligament are left intact.

Coverage of the denuded stump of radial neck is usually accomplished easily with the previously mentioned crescentic fold of synovial, but not fibrous, capsule, for in some cases where nature has been generous and trauma not too severe, this synovial capsular septum is nearly complete and forms a cover that requires only one or two interrupted sutures.

SUMMARY AND CONCLUSIONS

The presence of an occult chip fracture of the capitellum should be suspected in all fractures of the head of the radius.

Diagnosis of this lesion may be difficult as roentgenographic visualization is often inconclusive. Pneumoarthrograms, when carefully performed, may be helpful.

An anterior anatomic surgical approach to the elbow, as described, provides excellent exposure of the usual sites of pathology.

Correct early diagnosis and treatment is essential for good results.

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MEDICAL STATESMEN NEEDED

With increasing frequency the press and popular magazines carry expressions of dissatisfaction with various aspects of medical care. Is it not strange that such comments should be directed against the outstanding medical profession of the world? This situation needs serious thought and discussion. First, let us consider our accomplishments and then see if we can discover what is wrong.

The medical profession of this country is to be congratulated upon the phenomenal success it has achieved. For fifty years the surgeons have led this advance in the skilled application of basic scientific concepts to the treatment of disease. Other specialties have developed to a pinnacle of perfection the application of the scientific method. In the past decade the advent of chemotherapy and antibiotics has strengthened the armamentarium of the medical man and general practitioner until they can vie with the surgeon in offering concrete, effective therapeutic aid to their patients. To these accomplishments should be added the remarkable strides in preventive medicine and health education of the people. The American soldier in World War II received the best care of any soldier of any army in the world. The net result of this total medical

achievement has been the unprecedented increase in life expectancy in this country from 49.2 years in 1900 to 65.8 in 1945. This feat is unparalleled in the history of the world.

A great temptation exists to sit back and smugly point with pride to this magnificent result of the profession's efforts. Of course, the real student of medicine will never be content to take this attitude. Each new discovery only enlarges his concept of the vast unknown, and the doctor with the "leaven of science" in his soul will need no stronger stimulus to greater effort. Any who may be inclined to be complacent cannot fail to heed urgent prodding from another source. The people of this country are voicing their dissatisfaction with the distribution of medical services. Some localities have no doctors and many rural areas have an inadequate number. The majority find it difficult to pay for the highly skilled services the profession offers. Why has this situation arisen at the very moment of our greatest success? The answer is simple. The various groups have been so preoccupied with the intensive effort necessary to perfect special technics or to delve for new truths that they have not been fully cognizant of broad social and community needs. The distribution of medical services has not been planned with the same degree of intelligence and care that has gone into scientific pursuits. In many aspects it has been left entirely to chance.

If this be the correct etiologic diagnosis, what is the remedy? The specialist competent to deal with this problem should be a *medical statesman* of a caliber comparable to the level of professional skill already attained. He will need to consider the complaints of the public under two broad divisions. One concerns medical economics; the second, special and general graduate training of physicians. Let us consider them in this order.

The people in their need and frustration have called upon Government for relief. Shall we simply denounce this as a quack remedy? Would it not be more effective if the doctors were to take active, constructive leadership in the broad field of medical economics and study of community needs rather than to combat "socialized medicine" by the negative approach, using obviously biased counter-propaganda? In the latter case, the people's interests are sacrificed in the clash of ideas. Let the doctors assume the responsibilities of statesmanship and join with the leaders of various lay groups to give the intelligent leadership necessary to the solution of our common problem. In no better way can we obtain the sympathetic understanding and cooperation of the layman than by inviting him to think and plan with us as we consider methods of providing better

medical care for all the people. A beginning has already been made in the application of the insurance principle; the ten-point program of the American Medical Association is an excellent example. Lay and medical statesmen should know how to avoid the dangers of bureaucratic control of medical services. Local control, local responsibility, and local interest can be maintained in an effective program if the profession will take leadership. It can never be achieved by negative criticism alone. Indeed, we will be fortunate to escape federalized political control of the practice of medicine if a serious economic depression should come before the profession has taken positive action. There is not much time.

The second aspect of the situation concerns the training of recent graduates. This is the age of specialization—a natural and necessary result of scientific achievement—but how many and what kind of specialists do we need? More important, what is to become of the many who spend two or three postgraduate years in a narrow specialty only to be forced out of the hospital training program by competition? For example, most teaching hospitals have straight surgical services. The man who is dropped in the early years often goes into practice and does surgery in a small community, but he lacks fundamental training in the evaluation of patients and knows too little about general medical problems. Technical skill in surgery, which previously occupied such an important place in the training of the surgeon, is now sharing emphasis with accurate diagnosis and preoperative preparation of the patient. The internist should be the logical successor to the family doctor of earlier days. The surgeon would be more effective if he were first a good medical doctor. Then if, for any reason, he did not specialize he would be a more adequate practitioner.

At Emory we are developing the concept that there is no essential difference in a medical and a surgical case except for the brief period the patient spends in the operating room. In both medical and surgical cases sound evaluation of the patient and accurate diagnosis are mandatory. The preparation of the patient for surgery, as well as postoperative care, consists of an application of the principles of physiology and other basic sciences. Surely all specialists and all doctors should have a knowledge of and interest in both these aspects of patient care. In short, we should strive to develop broadly trained, competent doctors by the end of the second postgraduate year. Some will specialize, some will not. Then we can approach the ideal of having better specialists and better family doctors.

If one dared add another group to the list of specialists, it could well be named "Medical Statesmen."

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